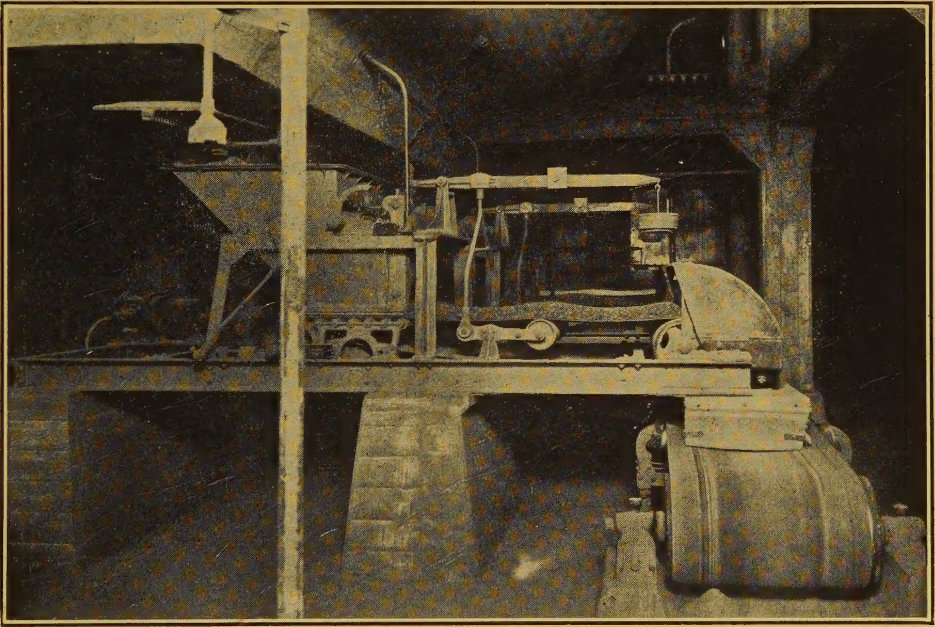
MILL SECTION of Concrete

Accurate Proportioning at Minimum Expense

High Quality Cement requires accurate mixture of both raw and finish materials, and as Schaffer Poidometers feed material by **WEIGHT** and **NOT VOLUME** with a high degree of accuracy, it will be to your advantage to investigate the Automatic Feeder, Weigher and Conveyor.



Three Schaffer Poidometers proportioning Clinker and Gypsum at the Davenport, California, plant of the Santa Cruz Portland Cement Company

Cement Mills Are Using Over 200 Schaffer Poidometers

They find them a most economical means of providing the more accurate proportioning made necessary by the new standards of cement manufacture. Poidometers assist in improving the quality of cement without adding to its manufacturing costs.

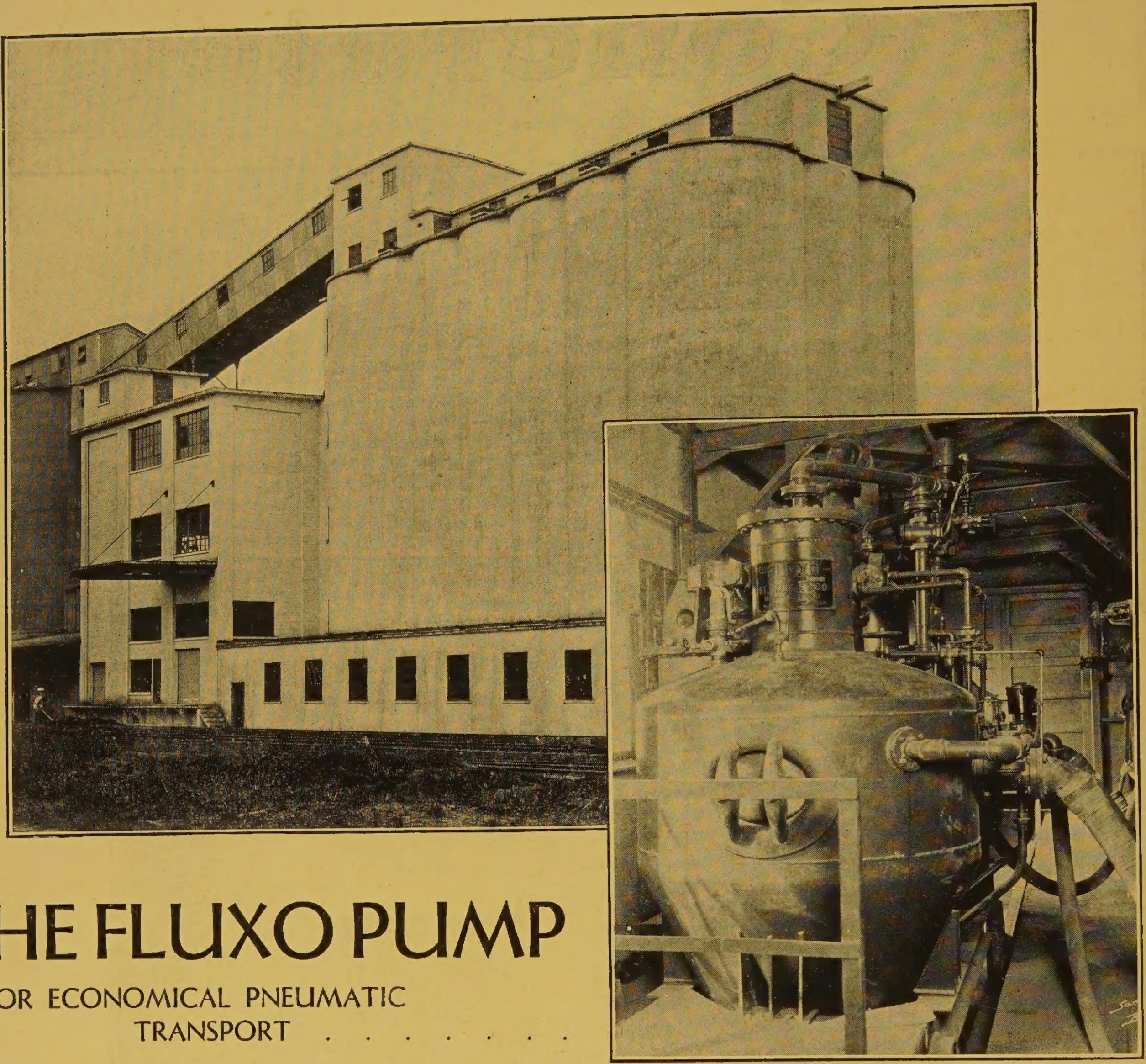
Write for Catalogue No. Seventy-Five

SCHAFFER POIDOMETER COMPANY
2818 Smallman St., Pittsburgh, Pa.

Branch Offices
BIRMINGHAM, ALA.
CHICAGO, ILL.
SAN FRANCISCO, CAL.

Index to Advertisers on Page 83 of This Section

PUMPING CEMENT



THE FLUXO PUMP

FOR ECONOMICAL PNEUMATIC TRANSPORT . . . .

The Fluxo has proved a very economical means for the pneumatic transport of dry pulverulent materials, such as cement, raw mix, lime, etc.

The illustration shows a Fluxo pumping cement from storage silos to bins over packing machines, and also from silo to silo. The operation is automatic and very simple.

When employed for removing the contents of silos, the Fluxo is installed outside the silo, drawing the material through a flexible hose from convenient points at the bottom of the silo. Thus no tunnels are required, simplifying the silo construction.

Forty systems have been sold to date.

Information regarding the application of the Fluxo pump to your transport problem will be gladly furnished.

F. L. SMIDTH & COMPANY

ENGINEERS

225 Broadway + + + New York, N. Y.

MILL SECTION of
Concrete

The Cement Mill Edition of Concrete is edited exclusively for those interested in the manufacture of cement. Its pages are devoted to discussions of plant design, management, operation, production efficiency, chemical research and control, quarry operation, progress and news of the industry.

The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition. The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

Volume 37 August, 1930 Number 2

CONTENTS

Effect of Magnesium Oxide on Clinker and Cement 85
Alton J. Blank presents an analysis of results obtained on a cement plant scale of operations.

Tariff Offers No Benefits in Interior Markets—Struckmann 87

Determining Uncombined Lime by Revised Procedure *(Illus.)* 88
An article by Wm. Lerch and R. H. Bogue recommending the ammonium acetate method as only satisfactory one available; description of procedure.

Editorial 93
Trimming the Cost of Selling.
Adding to Plant Investment.

June Campaign Results in Month Without Cement Plant Fatalities *(Illus.)* 91
Report shows new record made in industry; reports of regional meetings and trophy dedications.

Safe Practices in Cement Mill Shops 92

The Rate of Hydration of Cement Clinker *(Illus.)* 94
An abstracted paper by Anderegg and Hubbell, presenting the results of their continued studies.

How Mechanical Classifiers Reduce Grinding Costs *(Illus.)* 97
The principles of fine grinding, as developed in the copper industry, are told in an abstracted paper by Dorr and Marriott.

Cement Statistics for June *(Illus.)* 101

Men and Mills 102
Plant events and cement men's activities.

Mill Equipment 103

Canadian Co. Outlook Compares Favorably with 1929 104

In the Construction Section

~

Current Activities of Organized Groups 26

Study Fourteen Standard and Four Early-Strength Cements 27

Cement and Concrete Play Important Part in A. S. T. M. Meeting 20

New Books and Pamphlets 42

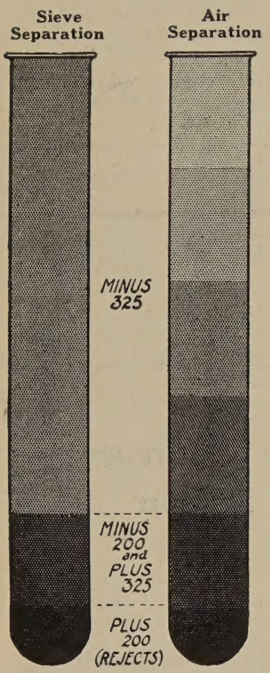
The Concrete Industry 25 Years Ago 53

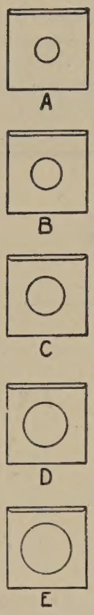
Copyright, 1930, by Concrete Publishing Co.

INDEX TO ADVERTISEMENTS

Allis-Chalmers Mfg. Co. 108
Autocar Co. 11
Bradley Pulverizer Co. 112
Caldwell & Son Co., H. W. 110
Chemical Rubber Co. 104
Du Pont de Nemours & Co., Inc., E. I. 106-107
Edge Moor Iron Co. 114
Engineering & Designing 78
Falla, Fernando 78
Federal Pneumatic Systems, Inc. 84
Fuller Co., The 109
Fuller Lehigh Co. 113
Huron Industries, Inc. 105
Jones Fdry. & Mch. Co., W. A. 112
Kritzer Co., The 78
Meade, Richard K., & Co. 78
Schaffer Poidometer Co. 81
Smidth, F. L., Co. 82
Super Cement Co., The 80
Texas Co., The 111
Timken Roller Bearing Co., The 12

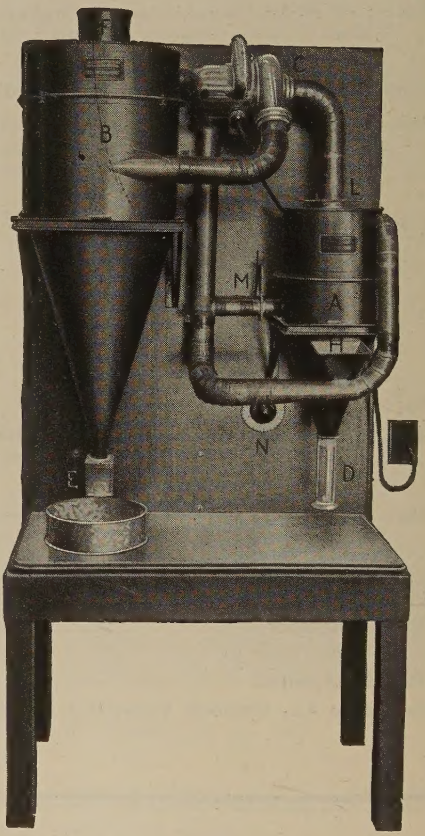
Cement must be expressed in microns *with* FEDERAL AIR SEPARATORS





ELEVEN distinct cement producers are now testing their finished material with the Federal Laboratory Air Separating Unit. Chemists in these plants are also testing competitors cement in order to learn whether their product carries more or less flour. If less, the problem then resolves itself into how to increase the flour without advancing cost of production. This is exactly where the Laboratory Unit renders an invaluable service to the cement manufacturer.

The effect of any change from the usual practice of blending, burning or feeding is revealed instantly when the finished cement is fractionated by means of the centrifugal separator.



Air volume is under control with 14 diaphragms stepped up ⅛″ and mesh adjustment with same number of diaphragms stepped up 1/16″. Four rates of feed are made possible with block diaphragms. Manifestly this insures wide range and enables the operator to log the samples.

The cement chemist usually employs 1½″ air control diaphragm between the separator and the fan inlet and by using 8/16″ mesh valve diaphragm removes from the aggregate concentrates which the microscope reveals to be 10 microns and finer. By substituting 10/16″ diaphragm material testing 10 to 20 microns is obtained and 11/16″ diaphragm, 20 to 30 microns. The residue may be fractionated with larger diaphragms or with 325 and 200 mesh test sieves.

The Federal Laboratory Unit is a precision instrument which enables the cement chemist to identify high early strength cement and promote it's economical milling. It also enables the producer to anticipate the market before installing commercial system.

Send for Bulletin 25

FEDERAL PNEUMATIC SYSTEMS, INC.
127 North Dearborn Street
Chicago, Illinois

MILL SECTION of

Concrete

Vol. 37 Chicago, August, 1930 No. 2

Effect of Magnesium Oxide on Clinker and Cement

An Analysis of Results Obtained on a Cement Plant Scale of Operations—Five Per Cent Limitation in Standard Specification Seems Justified

By ALTON J. BLANK
General Superintendent and Supervising Chemist, Compania de Cemento Portland "Landa," S. A.
Puebla, Puebla, Mexico

WHERE the early experts on portland cement manufacture and its use were quick to condemn cements comparatively high in magnesium oxide content, recent investigators have been more lenient in this respect. Until recent years, of the great number of cements rejected by engineers for failure to meet the chemical requirements of the cement specifications, those rejected through failure to meet the magnesium oxide requirements of the specifications were far in the majority. However, due to the findings of the more recent investigators, the magnesium oxide limits in the cement specifications have been gradually increased until at the present time few cements would be rejected for containing more than five per cent of this ingredient while, as a matter of fact, there are now few cements on the market containing magnesium oxide content in excess of this amount.

In these days of quick-hardening, high-early-strength portland cements, little attention is focused on the chemical composition of a cement.

Studying Effects of Magnesium Oxide Content

In the early days the presence of large percentages of magnesium oxide in a cement was frowned upon much in the same manner as is the presence of free lime in our cements of today. Then, as now in some quarters, it was generally concluded that cements containing high percentages of free magnesia and free lime, were usually unsound, and that, although each of the ingredients underwent a different reaction upon being mixed with water, the physical effect, that of expansion and disintegration, was the same. Further, in view of the fact that the magnesium compounds hydrate much more slowly than the lime compounds, it was therefore concluded that the two hydrations, the slow and the rapid one taking place in the cement, would eventually result in injury being done the structure.

Of the most recent investigators, Bates,[1] from results obtained with eighteen cements containing magnesium oxide in percentages of from 1.77 per cent to 25.53 per cent, among other things reports the following: "That portland cement with a magnesia content of about 9.5 per cent may be burned in a rotary kiln without producing a clinker materially different from one containing less than 4.0 per cent, though the clinkering temperature is somewhat lower for the former. That with greater amounts of magnesia present the resulting clinker is very vitreous and dusts more or less slowly. That high magnesia clinker is of a light brown color and that the strengths of the cement developed by neat, sand and concrete mixtures show cements containing 7.5 per cent of magnesium oxide to be satisfactory."

A number of years ago the writer was connected with a small cement plant which, at that time, on being first placed in operation, utilized materials high in magnesia content. Where the clay and shale were of normal compositions, the limestone varied in the quarry face from that of a high calcium limestone to that of an ordinary dolomite, the former containing less than 1.0 per cent of magnesia while the latter contained magnesia in percentages up to and exceeding 20.0 per cent. As a result, during the first several weeks of the plant's operation a number of different cements were manufactured containing magnesia contents of from 3.0 to 10.0 per cent; and inasmuch as the plant's operations were of a novel nature, the passage of the raw mixtures through the kiln was carefully noted, and extensive tests were carried out on each of the finished cements.

A High-Magnesia Mixture

The first raw mixture to reach the kiln contained excessive percentages of magnesia and its passage was brought to the attention of the operators through the formation of large "logs" as the material reached the burning zone. As these "logs" increased in diameter and length they gradually choked up the kiln and necessitated the operation of the kiln with very little flame. On being discharged from the kiln and being subjected to the cooling action of the outside air, the "logs" gradually flaked off and disintegrated into mounds of greyish-white powder. The second raw mixture passed to the kiln acted much the same as the first. On being ground to cement the following physical and chemical characteristics were noted:

---

[1] P. H. Bates, "Long-Time Tests of High-Magnesia Portland Cements," *A. S. T. M. Proceedings,* Volume 27, 1927.

Chemical Analysis	Cement No. 1 Per Cent	Cement No. 2 Per Cent
SiO_2	20.30	20.52
Al_2O_3	7.20	7.16
Fe_2O_3	3.02	2.96
CaO	56.10	57.02
MgO	9.88	8.84
SO_3	1.86	1.77
Ign. Loss	1.44	1.56
CaO/SiO_2	2.72	2.77
CaO/SiO_2 plus R_2O_3	1.82	1.84
Physical Characteristics:—		
Soundness	Soft	Soft
Initial Set	0 hr. 40 min.	1 hr. 25 min.
Final Set	2 hr. 50 min.	3 hr. 40 min.
Tension, 1:3, lbs. per sq. in.—		
7 days	172	203
28 days	Badly Bloated	Badly Bloated
3 months	Disintegrated	Disintegrated

Semi-High Magnesia

Raw mixtures Nos. 3 and 4 passed through the kiln in the form of soft-burning material which formed smaller "logs" and balls, together with ring formations, and upon being discharged from the kiln flaked off and disintegrated more slowly, requiring several hours to be reduced entirely to the powdered form.

These clinkers on being ground to cement showed the following characteristics:

Chemical Analysis	Cement No. 3 Per Cent	Cement No. 4 Per Cent
SiO_2	20.80	20.24
Al_2O_3	7.00	7.28
Fe_2O_3	2.84	3.12
CaO	58.40	59.74
MgO	7.56	6.20
SO_3	1.79	1.82
Ign. Loss	1.32	1.48
CaO/SiO_2	2.80	2.95
CaO/SiO_2 plus R_2O_3	1.80	1.94
Physical Characteristics:—		
Soundness	Fair	Good
Initial Set	2 hr. 25 min.	2 hr. 40 min.
Final Set	4 hr. 15 min.	4 hr. 45 min.
Tension, 1:3, lbs. per sq. in.—		
7 days	244	268
28 days	296	322
3 months	Badly Bloated	Bloated

Magnesia Cements Just Passing Specifications

Raw mixtures Nos. 5 and 6 passed through the kiln in the form of balls ranging in size from two inches and down, in good outputs which on being discharged from the kiln did not flake or disintegrate as had the earlier clinkers. These clinkers, on being ground to cement, showed the following characteristics:

Chemical Analysis	Cement No. 5 Per Cent	Cement No. 6 Per Cent
SiO_2	20.10	20.02
Al_2O_3	7.48	7.14
Fe_2O_3	3.20	2.86
CaO	60.76	61.34
MgO	5.28	4.76
SO_3	1.68	1.80
Ign. Loss	1.34	1.52
CaO/SiO_2	3.02	3.08
CaO/SiO_2 plus R_2O_3	1.97	2.04
Physical Characteristics:—		
Soundness	Good	Good
Initial Set	2 hr. 45 min.	2 hr. 50 min.
Final Set	5 hr. 00 min.	5 hr. 25 min.
Tension, 1:3, lbs. per sq. in.—		
7 days	295	306
28 days	384	410
3 months	446	474

Low-Magnesia Cements

Raw mixtures Nos. 7 and 8 passed through the kiln in normal outputs of ordinary size and color and did not disintegrate on being exposed to the outside air. These clinkers, on being ground to cement, showed the following characteristics:

Chemical Analysis	Cement No. 7 Per Cent	Cement No. 8 Per Cent
SiO_2	20.20	20.36
Al_2O_3	7.30	7.20
Fe_2O_3	3.20	3.16
CaO	62.28	63.06
MgO	3.84	2.98
SO_3	1.74	1.66
Ign. Loss	1.40	1.36
CaO/SiO_2	3.05	3.09
CaO/SiO_2 plus R_2O_3	2.03	2.05
Physical Characteristics:—		
Soundness	Good	Good
Initial Set	2 hr. 50 min.	3 hr. 20 min.
Final Set	5 hr. 30 min.	5 hr. 55 min.
Tension, 1:3, lbs. per sq. in.—		
7 days	318	332
28 days	427	464
3 months	472	497

These two latter cements are typical of the cements now being manufactured in the cement plant in question and are comparable with the average portland cement manufactured elsewhere.

Summary of Results

Cements Nos. 1 to 6 are necessarily freak cements manufactured only during the short time required to straighten out the quarry situation at the plant in question, and a summary of the results are given only for what they may be worth.

1.—High-Magnesia Cements

These cements make kiln operation difficult in that "logs" are formed which are detrimental to the kiln lining, these being formed at low temperatures. They have a tendency to "dust" on being exposed to the outside atmosphere. These cements are usually unsound, and though they may show certain strengths at early ages, usually disintegrate after seven days or more.

2.—Semi-High Magnesia Cements

These cements also tend to retard kiln operation through the formation of "logs," "balls" and "rings," together with making it difficult to keep a coating on the kiln linings. They have a lesser tendency to dust. These cements are of doubtful soundness, show little increases in strength between 7 and 28 day periods, and are inclined toward disintegration at later ages.

3.—Magnesia Cements Just Passing Specifications

These cements yield good kiln outputs at temperatures below normal. However, the clinker is slightly larger than ordinary clinker. They show no tendency toward "dusting," other chemical constituents being equal. These cements are sound and have good strengths.

4.—Low-Magnesia Cements

These cements yield normal kiln outputs at normal temperatures and have no tendency toward ring formations, the clinker being of normal size. They are sound and show good increases in strength at later ages.

All of the above cements were burned in an 8 by 125-ft. rotary kiln, and were tested in the laboratory in the usual manner.

Tariff Offers No Benefits in Interior Markets—Struckmann

The tariff rate on cement as provided in the new Hawley-Smoot schedule "will not in any way benefit the domestic producer in the interior markets," according to H. Struckmann, president of the International Cement Corporation, in the June 24th issue of the *Christian Science Monitor*. Domestic protection offered under the new rate is 6 cents for 100 pounds, or 22.8 cents a barrel, which is not sufficient, Mr. Struckman said, to "offset the advantages of many European manufacturers in American sea-coast markets."

"The brief filed with Congress by the cement industry in the interests of tariff showed," Mr. Struckmann continued, "that the advantage of the importer ranged from 38 cents a barrel at Galveston, Tex., to $1.16 a barrel at Miami, Fla. This advantage is due almost entirely to the direct and indirect labor charges in the manufacture and transportation of cement.

"The tariff granted will hardly be noticed by the cement industry for several months, as contract obligations outstanding are probably sufficient to take care of a considerable part of any business offered for some time. Ultimately the domestic producers should reap some benefit in the coastal markets but they will not in any way benefit in the interior markets.

St. Louis Portland Cement Co. Organized; to Build on Mississippi

Immediately upon selection of a site, construction of a $2,000,000 cement plant will be begun in the St. Louis industrial district by the St. Louis Portland Cement Company. Five sites on both sides of the Mississippi river are under consideration.

The company was recently incorporated with a capital of 1,000 shares of no par value common stock. The incorporators named are C. D. Nichols, Frank Krill, and R. H. Wiechert. Mr. Nichols is sales manager of the Oklahoma Portland Cement Company. Offices are located in the First National Bank Building, East St. Louis, Ill.

Newspaper reports state that the plant will have a daily capacity of 4,000 barrels, and that a large stone quarry and crusher for commercial operations will be opened.

Marquette Making Additions at St. Louis and Memphis Storage Plants

Extensive expansion programs have been launched by the Marquette Cement Manufacturing Company and actual construction is under way.

Additions costing $150,000, doubling the capacity of the Memphis, Tenn., storage plant will include two 60 ft. silos, sand and rock bins and elevators. Four new barges will be added to the present fleet. Completion is scheduled for September 1st.

A central mixing plant, to provide both wet and dry mixes, will also be begun soon.

Total holdings of the company in Memphis will be increased to property worth $600,000 following the expansion. Completion of the project will provide annual storage of 150,000 barrels of cement at Memphis for Missouri, Illinois, Kentucky, Tennessee, Arkansas and Mississippi.

Five silos to supplement the present storage and packing plant terminal on the Mississippi river at St. Louis will also be under way shortly. They will cost $75,000 and are to be completed before November 1st.

Reorganization of Northwestern States Company Planned

Plans for the reorganization of the Northwestern States Portland Cement Company, Mason City, Iowa, as an Iowa corporation, with several changes in the corporate structure, have been submitted to the stockholders.

The plans as outlined by a committee provide for the formation of a new corporation under Iowa laws with an authorized capital of 225,000 shares of stock without par value and recommends an exchange of four shares of new stock for each share of the old stock of $100 par value.

The present company was incorporated under the laws of West Virginia and except for a few amendments of minor importance, has remained substantially the same since its organization on April 3rd, 1906.

The plan for the reorganization was discussed at the annual meeting of the directors in December, 1929.

It is proposed that when the new company has been organized and is ready to transact business that a meeting of the stockholders of the old company will be called, at which time all of the assets of the company will be transferred to the new company.

Under the provisions made by the committee the stock certificates must be deposited by September 1st.

The reorganization plan also provides that purchase of stock in the company by Northwestern States employes is to be encouraged.

The proposed reorganization marks another step in the almost phenomenal growth of the Northwestern States Portland Cement Company since it was incorporated in 1906.

Most of the expansion which brought the plant to its present capacity, came during the 16 years when C. H. McNider, father of Colonel MacNider, the present head of the company, was the directing chief of its operations.

The construction of the mill was started shortly after the incorporation by the Cowham Engineering Company and was completed two years later. The construction and equipment of the plant were in accordance with the Cowham system of cement mills. W. F. Cowham of Jackson, Mich., was the first president of the company. He served in this capacity until his resignation in December, 1912.

Mr. Cowham was succeeded as president by Mr. McNider, who served until his death in October, 1928. During the 16 years under Mr. McNider's leadership the capacity of the plant was doubled. It was increased from its original capacity of 4,000 barrels daily to 8,000 barrels daily.

South Dakota Plant Pays $150,000 Toward Interest and Sinking Fund

One hundred fifty thousand dollars has been turned over to the state treasurer to apply on the South Dakota state cement plant's interest and sinking fund, its chairman announced at a meeting of the cement plant commission on June 25th.

The payment was the first made this calendar year, and according to officials, another will be made in December.

Determining Uncombined Lime By Revised Procedure

Ammonium Acetate Method Recommended as Only Satisfactory Method Available at Present—Procedure Described in Detail—Results in Seventeen Laboratories Compared—Probable Errors Determined

By WM. LERCH and R. H. BOGUE

THIS paper[1] presents a revised procedure, consisting essentially of an improved technique, for the determination of uncombined lime in portland cement by the ammonium acetate method. Factors which bear on the precision of the method are discussed and curves are presented which indicate the probable error of any group of determinations for a free CaO content up to 7 per cent.

In a former paper[2] the authors presented experimental evidence which indicated that a modification of the ammonium acetate titration method of Emley[3] was suitable for the determination of uncombined lime in portland cement.

In a recent publication, Diepschlag and Matting[4] have investigated a large number of methods for the determination of uncombined lime in slags and cements and conclude that the ammonium acetate method is the only method available at the present time which gives satisfactory quantitative results. Rathke[5] agrees that the ammonium acetate method gives satisfactory results but suggests that an alcoholic solution of tartaric acid as the titrating solution eliminates the necessity of boiling to volatilize the ammonia liberated during the titration. Inasmuch as boiling is required in either case, however, to bring the lime into solution, this method was not studied.

Since the publication of the earlier paper by the present authors, the ammonium acetate method has been employed extensively in this laboratory and in various cement and commercial laboratories for the determination of uncombined CaO. The method also has been applied, with some modifications, to the determination of $Ca(OH)_2$ in hydrated cement.[6] As a result of the experience obtained, certain modifications in the technique of the original procedure have been developed which advance the precision and reproducibility of the results. The revised procedure is presented at this time, together with an analysis of data obtained with the method. The procedure given is for uncombined CaO and does not consider the modifications necessary for the determination of $Ca(OH)_2$ in hydrated cement.

Revised Procedure

The determination is based on the solution of the uncombined CaO in a hot solution of glycerol and alcohol, and the subsequent titration of the dissolved lime with an alcoholic solution of ammonium acetate in accordance with the reaction:

$$CaO + 2CH_3COONH_4 = (CH_3COO)_2Ca + H_2O + 2NH_3.$$

A solution is prepared consisting of 1 part by volume of U. S. P. glycerol and 5 parts by volume of absolute ethyl alcohol or anhydrous alcohol denatured in accordance with the formulas 3-a or 2-b of the Bureau of Internal Revenue. To each liter of this solution are added 2 ml. of an indicator prepared by dissolving 1 gram of phenolphthalein in 100 ml. of absolute alcohol. It is essential that the glycerol-alcohol solution be neutral to the indicator. If the solution is colorless, a dilute alcoholic solution of sodium or potassium hydroxide is added until the pink color appears, and this just removed by a drop of an alcoholic solution of ammonium acetate. If the initial color is pink, it is just removed by the alcoholic solution of ammonium acetate.

A standard alcoholic solution of ammonium acetate, approximately 0.2 N, is required. Sixteen grams of crystalline ammonium acetate are dissolved in 1 liter of absolute ethyl alcohol or anhydrous alcohol denatured by formulas 3-a or 2-b. This solution is then standardized by titrating against pure calcium oxide. The calcium oxide should be freshly prepared by calcining pure calcite or calcium oxalate in a platinum crucible at 900 deg. to 1000 deg. C. to constant weight. Ordinary "C.P. CaO" should not be used. A few grams of the calcite or calcium oxalate are pulverized to an impalpable powder, heated as above and about 0.1 g. weighed and transferred into a 200-ml. Erlenmeyer flask containing 60 ml. of the neutralized glycerol-alcohol solution. The calcium oxide is dispersed in the solution by shaking; a water or air reflux condenser is inserted in the neck of the flask, and the mixture boiled for 20 minutes. The condenser is then removed and the solution titrated immediately, while near boiling, with the ammonium acetate solution. The condenser is replaced and the solution again boiled for 20 minutes. The titrations are repeated at 20-minute intervals, but the titration is not complete until no further color appears in the solution during continuous boiling for one hour. The value of the solution is then calculated in terms of grams of CaO equivalent to each milliliter of ammonium acetate solution.

The cement to be tested is first ground to an impalpable powder. A one-gram sample is weighed and transferred into a 200-ml. Erlenmeyer flask containing 60 ml. of the glycerol-alcohol solution. The flask is shaken to disperse the cement in the solution, the reflux condenser is attached, and the mixture boiled on the hot plate. Titrations are made, as in the standardization, at 20-minute intervals, and continued until no further color appears after boiling for one hour. In the final titrations, if there is doubt of the exact end point, a drop of indicator is added to the quiescent liquid in the flask, and the point at which the indicator strikes the solution is observed carefully. If no color appears, the end point has been reached. The uncombined lime content of the cement is then calculated from the known CaO value of the ammonium acetate solution used.

---

[1] Editorial abstract on Revised Procedure for the Determination of Uncombined Lime in Portland Cement. Publication approved by the Director of the National Bureau of Standards of the U. S. Department of Commerce. Paper No. 23 of the Portland Cement Association Fellowship at the Bureau of Standards.

[2] *Ind. Eng. Chem.*, 18 (1926), 739.

[3] *Trans. Am. Ceramic Soc.*, 17 (1915), 720.

[4] *Centr. Hutten Walzwerke* 31 (1927), 363.

[5] *Tonind. Ztg.*, 32 (1928), 1318.

[6] G. Assarsson and N. Sundius, Swedish Geological Survey, *Arsbok* 23 (1929), No. 2. L. T. Work and Lasseter, Columbia University, Personal Communication.

Comments on Procedure

The Solutions

It is essential that anhydrous alcohol be used in the preparation of the glycerol-alcohol solution, the ammonium acetate solution, and the phenolphthalein solution. Ordinary "pure" alcohol contains 4 or 5 per cent of water. Absolute ethyl alcohol or anhydrous alcohols denatured by formulas 3-a or 2-b of the Bureau of Internal Revenue are satisfactory. The anhydrous alcohols are obtainable through the industrial alcohol dealers on the same permit requirements as obtain for the less concentrated alcohols. If distillation permits are obtained, absolute alcohol may be prepared from 96 per cent ethyl alcohol by the following procedure[7]:

> To each liter of 96 per cent ethyl alcohol add about 300 g. freshly ignited lime. Allow to stand with occasional shaking for 3 or more days. Decant the clear alcohol and reject the residue. Add 100 g. freshly ignited lime and again allow to stand with occasional shaking for several days, protecting the alcohol from moist air. Siphon the clear liquid off with careful exclusion of moist-air. Boil in a flask with a reflux condenser for 8 hours after adding 25 g. freshly ignited finely powdered lime. Then distill the alcohol, protecting the distillate from moist-air with tubes of calcium chloride. Reject the first and last fractions of about 10 ml. per liter. Keep well stoppered to prevent ingress of moisture.

U. S. P. glycerol is satisfactory but, as this is hygroscopic, care must be taken to insure that it has been well protected from the moisture of the air.

A solution containing 1 part of glycerol to 5 parts of alcohol has been found to be most satisfactory. Although solution of the lime is more rapid when a higher concentration of glycerol is used, experiments have shown that some of the compounds of the cement are dissociated when the proportion of glycerol to alcohol is greater than 1 to 3. During the boiling operation some concentration of glycerol may occur due to evaporation of the alcohol, and as a precaution against dissociation by that process, it appears best to use a solution of 1 part of glycerol to 5 parts of alcohol.

Grinding and Weighing

For greater precision in establishing the standard values of the ammonium acetate solution an amount of calcite or calcium oxalate equivalent to about 0.1 g. CaO may be weighed into a platinum crucible, provided with a well-fitting cover. After calcination, the crucible and contents are weighed, reheated and reweighed rapidly with weights in place to avoid the possibility of any appreciable hydration or carbonation prior to obtaining the weight of CaO. Numerous tests with mixtures of known CaO value, however, have indicated that the error involved in the operations as given in the procedure is essentially negligible.

Likewise, the possibility suggests itself that some hydration and carbonation of the free CaO in the clinker may take place during the process of grinding. Mixtures of clinker with CaO, however, were found to have almost the theoretical free CaO values whether the CaO was ground with the clinker or added directly to the reaction flasks. It is well to emphasize, nevertheless, that the clinkers always should be freshly ground and placed in the glycerol-alcohol solution directly with no interim of standing in the laboratory before starting the analysis.

The Boiling Operation

It has been found necessary to prevent ingress of air to the flasks during the boiling operation because the lime brought into solution reacts readily with the carbon dioxide to form calcium carbonate. This carbonate does not react with the ammonium acetate during titration, so the lime results obtained are reduced in proportion to the amount of lime that reacts with the carbon dioxide. It has been found that the amount of lime carbonated is inappreciable if the solution is kept boiling vigorously. This causes a current of vapor passing upward and prevents the ingress of air. Boiling in this manner in an open flask, however, brings about a considerable loss in alcohol and, by the consequent concentration of the glycerol solution (unless the alcohol is replenished at frequent intervals), disintegration of the calcium compounds of the cement will follow. The use of a reflux condenser, and positive but not violent ebullition, combine to prevent ingress of carbon dioxide and at the same time avoid loss of alcohol. But even with the use of the condenser, a very slow boiling will permit ingress of the carbon dioxide, and give low results, while a violent boiling and loss of alcohol will tend to make the glycerol more concentrated, and give high results.

The condenser may be water-cooled or air-cooled. A glass tube about 6 mm. in diameter and 45 cm. in length, inserted in a stopper and attached to the flask, is satisfactory. If new rubber stoppers are employed, they should be washed to remove the white powder on them before use. Cork stoppers are more satisfactory.

If it is necessary to leave the test incompleted, the condenser should be removed, the solution titrated to the end point, and the flask tightly stoppered. Titrations should not be repeated, on renewing the test, until the solution has been boiled in the usual manner.

The Titration

In order to prevent ingress of carbon dioxide, titrations are made immediately upon removing the condenser, and while the solution is still near the boiling point. Samples titrated to completion while hot may develop a pink color on cooling, due to a difference in the end points in hot and cold solutions. Hence both in standardization and in the determinations, the solutions should always be titrated while hot. The end points are better recognized in bright white light, but not in direct sunlight.

The time required for the determinations will vary from 3 to 8 or more hours, depending on the amount of lime present, the fineness of the sample and the nature of the cement. A high lime content, a coarsely ground sample, or a high burned product each make for slower reaction and a longer required boiling period.

The time interval between titrations is best maintained at 20 to 30 minutes. When boiling is continued for longer periods without titration, crystals are formed which are probably calcium glyceride. These will slowly go into solution again as the lime of the solution is reduced by the ammonium acetate, but the total time required for the determination may be increased.

The introduction of ammonium acetate beyond the end point of each titration is to be avoided because the ammonium acetate is found to react slowly with some compound or compounds in the cement other than lime. The presence of an excess of the ammonium acetate, therefore, will cause lime, other than that uncombined in the cement, to react, and so high results will be obtained.

---

[7] Condensed from paper by N. S. Osborne, E. C. McKelvy, and H. W. Bearce, *Bur. Standards Scientific Paper* 197 (1913).

For this reason, as pointed out by H. H. Steinour and H. Woods,[8] it is not permissible to add an excess of the ammonium acetate solution at the start and, after a given time period, titrate back with alcoholic potassium hydroxide.

Results Obtained with Revised Procedure

Supplies of eight cements were obtained; some were commercial products and others were cements so prepared in the laboratory that a wide range of uncombined lime values might be available. Samples of each cement were submitted in sealed bottles to seventeen laboratories together with a copy of the revised procedure for the determination of uncombined lime.

The mean uncombined CaO values obtained by these laboratories on the eight cements are given in Table I, together with the maximum and minimum values obtained, the average deviation from the mean, the per cent average deviation from the mean and the probable error.

TABLE I

Results With Revised Procedure for Uncombined Lime Obtained on 8 *Laboratory and Commercial Cements by* 17 *Laboratories*

	Cement Number							
	1	8	2	5	3	6	4	7
Mean (17 laboratories)	7.4	6.6	4.3	2.4	1.6	0.9	0.3	0.1
Maximum value obtained	8.5	7.8	5.3	3.1	2.2	1.9	0.6	0.5
Minimum value obtained	6.3	5.7	3.2	1.7	0.9	0.6	0.0	0.0
Av. deviation from mean	.5	.4	.4	.3	.3	.2	.1	.1
Per cent average deviation from mean	6.8	6.1	9.3	12.5	18.7	22.2	33.3	100.0
Probable error	.41	.38	.36	.29	.28	.14	.12	.06

The average deviations from the means are obtained by averaging the actual deviations of each laboratory without regard to sign. They represent the average spread of individual values from the mean for each sample of cement. The percentage average deviation from the mean is obtained by dividing the average deviation by the mean value for each cement.

It will be observed that the average deviations from the means vary from 0.1 to 0.5, and the per cent average deviations vary from 6.1 to 100. By plotting the per cent average deviations against the mean values for uncombined CaO, the curve shown in Fig. 1 is obtained. It may be noted that the per cent average deviations vary in a regular manner with the mean value for the uncombined lime present. By means of the curve one may read the most probable value for the per cent average deviation at any content of uncombined lime up to about 7 per cent.

The probable error, defined as that deviation from the mean within which one-half of a large number of determinations may be expected to fall, also was calculated for each cement. Probable error is determined[9] by an application of the principle of least squares in accordance with the equation:

$$r = 0.6745 \frac{\Sigma_{v2}}{n - 1}$$

where r is the probable error of a given group of determinations from the most probable value as represented by the mean of a large number of group determinations, Σ_{v2} is the sum of the squares of the residuals or deviations from the means, and n is the number of group determinations under consideration. The values obtained are shown in Table I. It should be pointed out that the probable errors as here determined represent the probable deviations from the best results that can be obtained by the method and bear no necessary relation to the true values.

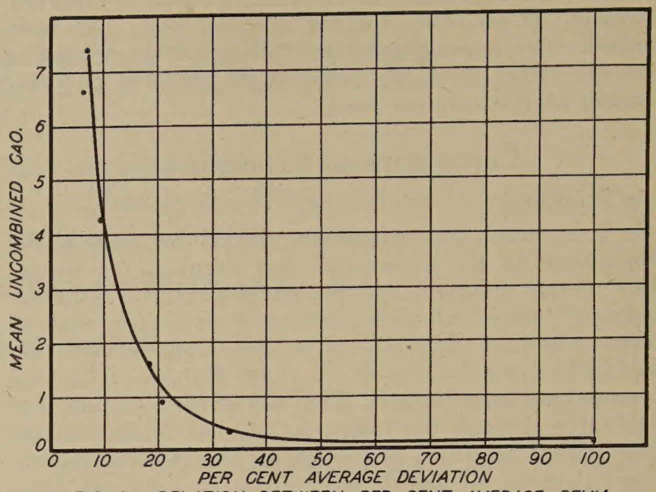


FIG. 1—RELATION BETWEEN PER CENT AVERAGE DEVIATION AND UNCOMBINED CAO.

In Fig. 2 the probable errors are plotted on the abscissa against the mean values for uncombined CaO on the ordinates. From this figure, the probable error of any group of determinations may be read at any mean value for uncombined CaO up to about 7 per cent. For example, if the mean value for uncombined CaO as obtained by several laboratories is 2.0 per cent, the chances are equal that a given laboratory will obtain a figure which differs from 2.0 per cent by not more than 0.3; i. e., 2.0 plus or minus 0.3 per cent. Of course the chances also are equal that any laboratory will obtain a figure which differs from the mean by more than the probable error.

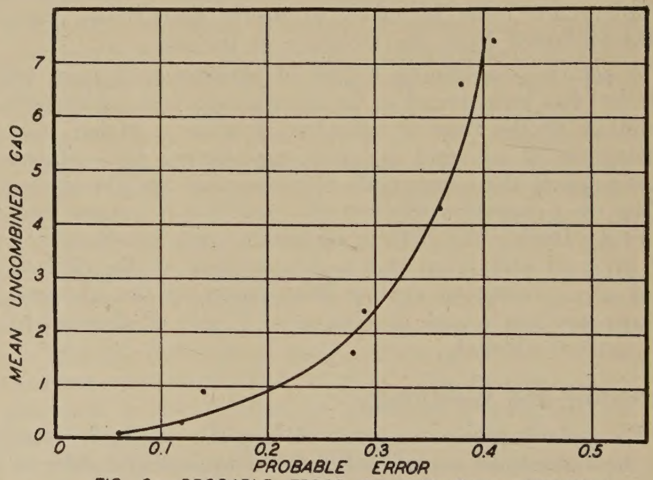


FIG. 2—PROBABLE ERROR OF INDIVIDUAL DETERMINATIONS OF UNCOMBINED CAO FROM THE MEAN VALUE OF SEVERAL LABORATORIES

Summary

A revised procedure for the determination of uncombined lime in portland cements by the ammonium acetate titration method is presented. Various factors which bear on the precision of the test are discussed.

A curve is given which shows that the percentage average deviation from the mean varies with the mean value for uncombined CaO.

The probable errors have been determined and a curve is given which shows the probable error of any group of determinations from the mean, at any mean uncombined CaO content up to 7 per cent.

---

[8] *Rock Products* 32 *No.* 4 (1929), 74.

[9] *Cf.* M. Merriman, "Method of least squares," New York, p. 66.

June Campaign Results in Month Without Cement Plant Fatalities

Reports of Regional Meetings and Trophy Dedications—Lost-Time Accidents Equal to Those of 1929 — 137 Plants Report

THE portland cement industry achieved one of its goals in the June safety campaign by completing the month without a fatal accident. Apparently complete reports from Portland Cement Association member plants showed a total of 38 lost-time accidents. There were 3 fatal and 38 lost-time accidents in the same month in 1929. One-hundred thirty-seven plants reported.

The 38 accidents occurred in 23 plants. Of this number, eighteen plants suffered one lost time accident; six plants suffered two lost time accidents and one plant suffered eight lost time accidents. These accidents were distributed among the various departments as follows: Quarry 12, raw mill 4, burning 3, finishing 3, crushing 2, packing and shipping 1, power 1 and yard 1. Eleven additional accidents occurred which are not yet possible to distribute by department.

Fewer Days Lost

Absence of fatal accidents during June recalls the recession in fatal accident rate during the first six months of 1930. During the period from January 1st to June 30th only 7 fatals were reported, as against 17 fatals reported during the corresponding period of 1929. While the total number of lost time and fatal accidents reported for the first half of 1930 is approximately equal to those for the first half of 1929, there seem to be fewer days lost. Improvement appears to have shifted from accident frequency to accident severity. By reason of fewer fatalities, fewer disabilities and less loss of time, it is estimated that member plants are ahead of last year's severity rating to the extent of 75,000 to 80,000 days.

Regional Safety Meetings

A balance of three regional safety meetings remains on the Portland Cement Association schedule for the year. These are to be held at Seattle, Washington, September 9th; at San Francisco, September 16th, and at Ogden, Utah, September 23rd.

The Seattle meeting, to be held at the New Washington Hotel, will be in charge of C. N. Reitze. The bureau of mines will be represented by S. H. Ash.

J. H. Colton will be general chairman of the meeting on September 16th at the Hotel St. Francisco, San Francisco. S. H. Ash will again represent the bureau of mines.

The Utah meeting will be presided over by P. R. Dorland and the bureau of mines will be represented by D. J. Parke.

Three meetings recently held were those at Detroit, Cleveland, and Washington, D. C.

Seventy-five persons attended the Michigan gathering, held at the Book-Cadillac hotel on July 8th. L. A. Hutchins acted as chairman. The general subject was "Safe Practices in the Cement Industry," and this topic was discussed by 5 department heads of different plants. M. J. Ankeny represented the bureau of mines and conducted the first-aid contest.

Secretary of Labor James J. Davis was the principal speaker at the conference of mills of Virginia, Maryland, and southwestern Pennsylvania, held at the Raleigh Hotel, Washington. The meeting was attended by 80 operating executives, superintendents and safety directors.

Other speakers during the session included Daniel Harrington, chief engineer of the bureau of mines; Col. H. A. Reninger, Dwight Morgan and Wm. M. Powell.

John J. Porter acted as general chairman.

The meeting held on June 24th, in the Hotel Cleveland, at Cleveland, Ohio, was attended by about ninety delegates.

The address of welcome was made by J. B. John, chairman of the committee on accident prevention of the association, followed by a report of safety work in the cement

Scene at the dedication of the trophy awarded to the Lehigh Portland Cement Company plant at Ormrod, Pa.

industry in 1929, by A. J. R. Curtis. Other talks on various angles of safety and motion pictures of dynamite handling comprised the balance of the program.

Trophy Dedications

The dedication of the Portland Cement Association trophy awarded to the Lone Star Cement Co., Virginia, Inc., for its no-accident record for 1929 was held at the plant at South Norfolk on July 10th.

G. F. Martinez made the speech of acceptance for the plant and E. Posselt for the International Cement Corporation. The principal address of the day was made by Col. Chas. B. Borland. Dwight Morgan acted as chairman and Geo. F. Martinez was master of ceremonies.

Dedication of the trophy awarded to the Hercules Cement Corporation took place at Stockertown, Pa., on Friday, July 11th. J. Stanley Downs made the opening address. Marvin Parsons made the speech of acceptance, and the address of the day was delivered by Morris Kind.

D. S. MacBride was chairman of the ceremonies held at the Nazareth, Pa., plant of the Lone Star Cement Co., Pennsylvania, on July 11th. Acceptance of the trophy was by E. C. Champion and Hon. W. R. Coyle made the address of the day. Two other events on the program were the presentations of first aid training certificates awarded by the Department of Commerce to 16 employes and of group life insurance policies to a number of employes.

J. W. Johnston presided at the dedicatory ceremonies of the Birmingham mill of the Lone Star Cement Co., Alabama. Acceptance of the trophy was by W. M. Cabaniss, followed by addresses by A. D. Stancliff, E. Posselt and Allen G. Loehr.

The safety trophy of the Spocari mill of the Lone Star Cement Co., Alabama, was dedicated on July 16th, when R. M. Braden presided as master of ceremonies. W. W. Deadman accepted the trophy on behalf of the plant. Addresses by E. Posselt, A. D. Stancliff, Arthur Akers, and J. W. Johnston, followed.

A. J. R. Curtis, assistant to the general manager of the association, made all presentations.

Safe Practices in Cement Mill Shops

By H. A. TILLOTSON

Chief Engineer, Petoskey Portland Cement Co., Petoskey, Mich.

Avoiding Injuries to Eyes—Instances of Gross Carelessness—Some Pointers on Machine Shop Practice—Good Housekeeping Promotes Safety in Shop and Mill

This meeting is made up of men who come from plants where there is a safety organization of one kind or another. You men know what constitutes safe practices. You all know you should wear goggles when chipping and when using an emery wheel. You know you should store oxygen and acetylene tanks in a safe manner and put up a shield around the electric welder. While the conditions in one plant are quite similar to those in another there are, of course, details that vary with each particular situation and must be met by the men doing the jobs.

Rules and standing orders are all very good for some things and safeguards are all right for other places; but the best safety device is a careful and thoughtful worker.

Would you say that safety was uppermost in the mind of a man who stood on one side of a steel plate while his fellow worker on the other side burned the edge off with an acetylene torch, the hot metal and sparks flying all around him? Nobody knows why they did not get in his eyes. Do you think the pipe fitters who climbed down from the top of a steaming boiler and jumped on a quarter inch pipe leading to the water column was thinking safely, if thinking at all? And how about the electrician who went in behind the switchboard to test a 2300-volt fuse with an ordinary test lamp? It is such carelessness which must be eliminated before we can have entirely safe plants.

Good Housekeeping and Shop Practice

Another thing that will help to make a shop safe is good housekeeping. Keep the floor and walkways free from rubbish and scrap. It is good practice to put scrap in its proper place as fast as it is made and to store usable scrap in a safe and workmanlike manner.

Another practice that helps prevent accidents is to bring jobs into the shop only as they can be taken care of. Avoid cluttering up the shop with jobs that can not be done for several days, but which create stumbling blocks in the meantime. When a job is completed it should be properly placed and the job next in importance brought in. Cement mill machinery and equipment is cumbersome and heavy and creates unsafe conditions when allowed to lie around on a shop floor.

Surely good system is very helpful, but safeguards, preaching and system can never accomplish all that is intended until you have an organization that functions as it should. You can not build that in a day. We all have human weaknesses and human likes and dislikes. By constant leading and coaching and helping, with now and then the proper disciplinary measures, an organization can be built that will further the cause of safety effectively and help win the trophy which we all so much desire.

Paper read at regional safety meeting of Portland Cement Association at Detroit, Mich., July 1st.

Ohio Cement Production Exceeds that of Gold in United States

The value of portland cement made each year from Ohio limestone is slightly greater than that of all the gold mined in the United States annually, according to information contained in a book, "Know Ohio," prepared by the state department of education.

The authors point out that the value of all the gold mined in the United States is $45,360,000, as compared to $45,552,000 value of the portland cement made yearly from Ohio limestone.

Louisville Cement Incorporated for $1,500,000

Articles of incorporation involving $1,500,000 worth of capital stock were filed by the Louisville Cement Company, Speed, Ind., on June 28th. The incorporators named are Floyd H. Compton, Jonas G. Howard, and John M. Buchheit.

North American Reports $50,000 Loss for First Half of Year

The North American Cement Corporation, Albany, N. Y., reports for the six months ended June 30th, a net loss of $49,374 after taxes, interest, depreciation and depletion.

Lehigh Dividend

The Lehigh Portland Cement Co. declared the regular quarterly dividend of 62½ cents on common stock, payable August 1st to stock of record July 14th.

EDITORIAL

Trimming the Cost of Selling

THE high cost of selling is troubling the cement industry. There is nothing surprising about this fact, for similar troubles are besetting every industry that is represented by a number of individual units operating on a competitive basis.

There is a bright side to the situation, for the cement industry is in a mood to do something about it. Both formally and informally the question has been under discussion for some time, and unless past history fails to repeat itself, a way will be found to eliminate much of the waste that now prevails.

It is asserted that both in 1928 and 1929 the cement industry spent nearly 25 million dollars to sell about 170 million barrels of cement. This is many times the amount spent by the industry's promotional organization on its vast program of creating markets through research and educational work.

The foregoing figures mean that it costs the sales departments of the cement manufacturing companies an average of just under 14 cents a barrel to sell cement. If even a fourth of this sales cost could be trimmed off, and if only a part of the saving were turned into the channels of research and educational work, the amount available for this worthy purpose might easily be doubled.

If, as a cement company official recently stated, the expenditures for worthless advertising could be eliminated—advertising placed in nondescript journals as a favor to a friend of someone—more money would be available for advertising in publications that reach a market.

Then there is the most difficult problem of all—the problem of maintaining salesmen in the field. Here again the highly competitive conditions in the industry are at the bottom of the trouble. For illustration, a contract was awarded for a concrete street pavement in a small midwestern city. The sale of a certain amount of portland cement was thereby assured; but because of the competition prevailing, eight salesmen representing as many different cement manufacturing companies were present in the interest of their particular brands.

The successful bidder, who probably knew beforehand which brand of cement he wanted, had left the city early in the afternoon. With the visiting salesmen all set to entertain the successful bidder, someone had to be entertained. They entertained each other, some of them far into the night, presumably at the expense of six or seven different sales appropriations.

A far more aggravated case was reported in the spring of this year, from an eastern city, when 52 cement salesmen attended a large concrete road letting. Under the competitive conditions existing, each of the salesmen was justified in being there.

These two illustrations, after all, are only typical of what is occurring somewhere almost every day. The solution is an extremely difficult one. It may come eventually through the pooling of sales organizations, if a method can be developed that is legal as well as workable. Whatever the ultimate solution, no stone should be left unturned until it is found.

Adding to Plant Investment

NO one will envy the position of the cement manufacturer who is confronted with the necessity of making further alterations and additions to plant equipment. Many mills are now overloaded with plant investment, for it is a difficult matter to write off equipment fast enough in an industry where developments are coming so rapidly.

First of all, there is the question of closed-circuit grinding; and if such a system is to be installed, shall it be a mechanical classifier or a system of air separation?

Another question is that of waste heat recovery, for many mills have not as yet installed this equipment. It means additional plant investment, including waste heat boilers to generate steam, and electric generators to convert steam energy into electric power. The old direct-fired boiler plant must be scrapped, but the new equipment will produce more than enough electric power to operate the entire mill.

Not all wet-process plants are equipped with slurry filters. Shall they be installed, and if so, shall the disc type or the drum type be adopted? Filters will more than pay for themselves, for they will greatly reduce the moisture content of the slurry, thereby increasing the output of the rotary kilns.

Dust collectors, too, are made in several types, so that a decision to install dust collection equipment must be accompanied by a decision on the type to be selected. Here again the additional plant investment will recover from 4 to 5 per cent of the raw and finished product which formerly was wasted, and the life of mechanical equipment will be prolonged because of the absence of dust.

Conveying equipment is constantly undergoing improvement. No matter which way the cement manufacturer turns, he will see equipment that should be replaced, not because it is worn out, but because it has been made obsolete by newer and better equipment through which production costs can be lowered.

Fortunate is the cement manufacturer who possesses wisdom and courage, and the ability to push forward the new installations needed to keep his plant in the low production cost class.

The Rate of Hydration of Cement Clinker

Part II—Portland Cement at Nine and Twelve Months
Part III—Three Minerals Found in Portland Cement

By F. O. ANDEREGG[1] and D. S. HUBBELL[2]

Synopsis

Part II.—Standard portland cement particles, whose earlier reaction rate had been previously reported and whose original dimensions were 15 to 25 microns, were found to be approaching apparently complete hydration in nine months, while at twelve months hydration was practically finished. A white portland cement and an early-strength portland cement seemed to reach a similar degree of hydration in a shorter time.

Part III.—The hydration rate of tricalcium aluminate was found to be quite high, particles of a dimension of about 25 microns being about three-quarters hydrated in 3 hours. Tricalcium-silicate particles of the same size required about 7 days for a similar degree of hydration, while with dicalcium silicate this amount of hydration was reached only after 5.5 months. The early rates for the portland cements studied appeared to be intermediate between those of the two silicates. In general, mixtures of minerals reacted more rapidly than single minerals. This was true especially for the mixture roughly approximating the portland cement in composition.

Part II—Portland Cement at Nine and Twelve Months

THE methods described in the authors' paper before the Society last year[3] have been followed in obtaining and calculating the results reported here. (See Table I and Fig. 1.) During the investigation of the hydration rates of the pure minerals described in Part III, it was found advisable to grind the partially hydrated materials under oil. This raised the question as to whether partially hydrated commercial portland cements, on grinding in the air, might undergo further hydration. Direct comparisons between the two methods, however, showed that the two methods gave results checking within 1 per cent.

At 9 months the effect of calcium sulphate or chloride on the rate of hydration was negligible.

At 12 months the unhydrated residue was quite small.

The apparent depth of hydration of the standard portland cement (portland cement A) at 9 months was about 7.2 microns as compared with 3.54 at one month and 5.12 at 3 months.

The white portland cement was apparently more hydrated at 5 months than the standard gray cement (portland cement B) at 9 months.

At 5 months the high-early strength portland cement (portland cement C) was more completely hydrated than any of the others.

Part III—Three Minerals Found in Portland Cement

Through the courtesy of R. H. Bogue, samples of tricalcium aluminate, tricalcium silicate, dicalcium silicate and calcium ferro-aluminate prepared by the Portland Cement Association Fellowship at the U. S. Bureau of Standards have been studied, using the methods of experimenting and calculating previously described. A slight modification was introduced by grinding the partially hydrated mineral under oil because the speeds of reaction were such that progressive hydration occurred during grinding of these minerals in air.

The impurities in the minerals were determined by observing the optical properties of about one thousand particles of each fraction separated for the determination. Since there were four or five fractions of every mineral, the number of particles of each studied was in the neighborhood of four thousand. In tricalcium aluminate inert material to the extent of 1.7 per cent, mostly calcite, was found; in dicalcium silicate the inert substances aggregated 2.15 per cent, about one-half being calcite; while in tricalcium silicate the inert compounds were negligible, but the dicalcium silicate was found to be 8.85 per cent. A suitable correction was made for these impurities.

The specific gravities needed in the calculations were determined on the unhydrated, separated minerals and on those ground repeatedly with water. After the latter operation the portion remaining unhydrated was determined in the usual way by a special count. It was very small for the trisilicate and trialuminate, but rather large for the disilicate. The gravities observed before hydration were 3.026, 3.020 and 3.233 and after hydration and correction for unhydrated mineral, 2.15, 2.49 and 3.00, respectively. Thorvaldson, Grace and Vigfusson[4] report a density of 2.522 for $3CaO.Al_2O_3.6H_2O$.

The dicalcium silicate, both before and after hydration, appeared to be heaviest. The specific gravity of the partially hydrated dicalcium silicate appearing to be somewhat high, the determination was repeated, with results similar to those obtained during the first trial.

Calcium sulphate (1.6 per cent by weight as $CaSO_4$ $2H_2O$) was added in part of the experiments. A few mixtures of minerals were observed, including one roughly approximating commercial portland cement in composition. Calcium ferro-aluminate was added in small amounts to each of the three minerals to see what effect the presence of this iron compound might have on the reaction rate of the others. Iron oxide, being positive in character, might join with the negative silica to form a more compact gel which could be expected to slow up the passage

---

[1] Senior Industrial Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[2] Industrial Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[3] The first paper by the authors on this subject (Part I) was presented at the annual meeting of the Society in 1929; see *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II, p. 554 (1929) and republished in the August, 1929, issue of CONCRETE. Parts II and III, here reprinted, were presented on June 27, 1930, at the thirty-third annual meeting of the American Society for Testing Materials.

[4] T. Thorvaldson, N. S. Grace and V. A. Vigfusson, "The Hydration of the Aluminates of Calcium. II. The Hydration Products of Tricalcium Aluminate," *Canadian Journal of Research*, Vol. 1, p. 203 (1929).

TABLE I

Hydration of Portland Cement at Longer Periods

Mean dimension, microns	Conditions	3½ months Percentage hydrated	3½ months Depth of hydration, microns	5 months Percentage hydrated	5 months Depth of hydration, microns	9 months Percentage hydrated	9 months Depth of hydration, microns	12 months Percentage hydrated	12 months Depth of hydration, microns
	PORTLAND CEMENT A								
20.69	Calcium sulphate added	—	—	—	—	—	—	97.68	Complete
25.53		—	—	—	—	—	—	98.53	Complete
15.53	No calcium sulphate added	—	—	—	—	95.78	5.07	97.33	Complete
20.69		—	—	—	—	95.67	6.71	97.68	Complete
22.05		—	—	—	—	94.00	6.71	97.79	Complete
23.57		—	—	—	—	96.32	7.86	97.74	Complete
23.57		—	—	—	—	—	—	98.09	Complete
25.53		—	—	—	—	96.02	8.41	98.00	Complete
25.53		—	—	—	—	94.17	7.81	98.53	Complete
27.45		—	—	—	—	—	—	98.54	Complete
23.57	$CaCl_2$ 0.7% of cement and sulphate	—	—	—	—	96.32	7.86	98.09	Complete
20.69	1.4 normal consistency	—	—	—	—	—	—	97.84	Complete
							Avg. 7.20		
	PORTLAND CEMENT B								
26.73	—	88.25	6.82	—	—	84.58	8.30	—	—
	PORTLAND CEMENT C								
27.13	—	—	—	95.85	8.87	—	—	—	—
	WHITE PORTLAND CEMENT								
27.98	—	—	—	91.77	7.90	—	—	—	—

of the reacting water toward the unhydrated cores. However, no evidence in support of this supposition was obtained probably because of the great reactivity of this compound itself for water.

The experiments were carried out at room temperature (7 ± 5 deg. F.) and all specimens were stored in water until the reaction was stopped by sudden heating of the finely divided specimens. The data are presented in Table II and Fig. 2. Tricalcium aluminate was hydrated most rapidly of the three binary minerals. Tricalcium silicate was not far behind, while dicalcium silicate had a comparatively slow reaction rate. The rates for the commercial portland cements were intermediate between the two silicates at ages up to seven days, as shown in Fig. 2.

In general, the mixtures of minerals reacted more rapidly with water than the single compounds. This was very marked whenever calcium ferro-aluminate was added.

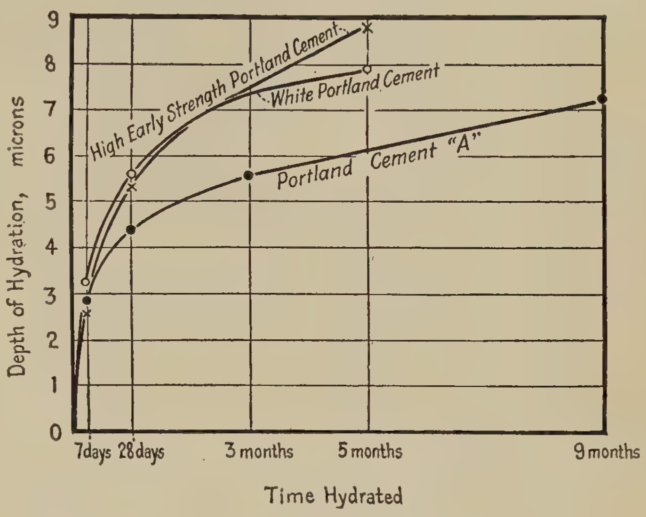


Fig. 1. Depth of hydration of portland cement clinker at given time intervals

TABLE II

Hydration of Minerals Found in Portland Cement

Mean Dimension, microns,	Conditions	1 minute Percentage Hydrated	1 minute Depth of Hydration. See Table I	15 minutes Percentage Hydrated	15 minutes Depth of Hydration, microns	3 hours Percentage Hydrated	3 hours Depth of Hydration, microns	24 hours Percentage Hydrated	24 hours Depth of Hydration, microns	3 days Percentage Hydrated	3 days Depth of Hydration, microns	7 days Percentage Hydrated	7 days Depth of Hydration, microns	28 days Percentage Hydrated	28 days Depth of Hydration, microns	5½ months Percentage Hydrated	5½ months Depth of Hydration, microns
	TRICALCIUM ALUMINATE																
19.06	No calcium sulphate added	—	—	—	—	79.1 79.2	3.82 3.90	—	—	89.67	5.09	—	—	—	—	—	—
22.20		—	—	—	—	79.78	4.58	—	—	88.86	5.76	—	—	—	—	97.71	Complete
25.65		15.55	0.69	42.24	2.14	79.97	5.37	—	—	87.42	6.39	—	—	—	—	—	—
22.20	1.6 per cent calcium sulphate added	—	—	—	—	74.53	4.07	—	—	87.12	5.49	—	—	88.24	5.66	97.52	Complete
	Mean	—	0.69	—	2.14	—	4.35	—	—	—	5.68	—	—	—	5.66	—	—
	Mixtures:																
23.64	10 per cent calcium ferro-aluminate	—	—	—	—	85.56	5.62	—	—	88.80	6.14	—	—	—	—	—	—
25.65	10 per cent calcium ferro-aluminate	—	—	—	—	85.58	6.10	—	—	90.37	6.94	—	—	—	—	—	—
	TRICALCIUM SILICATE																
25.20	No calcium sulphate added	—	—	—	—	39.70	1.96	42.40	2.12	—	—	76.80	4.76	75.10	4.68	—	—
21.86		—	—	—	—	58.60	2.13	—	—	—	—	74.70	3.47	—	—	—	—
19.06		22.0	0.96	27.0	1.15	27.20	0.96	43.00	1.63	—	—	—	—	82.45	4.19	93.85‡	5.77‡
25.20	1.6 per cent calcium sulphate added	—	—	—	—	—	—	55.00	2.99	—	—	74.75	4.74*	—	—	—	—
	Mean	—	—	—	—	—	1.68	—	2.25	—	—	—	4.32	—	4.44	—	
25.20	With 10 per cent calcium ferro-aluminate	—	—	96.40	8.44	—	—	99.30	10.19	—	—	—	—	—	—	—	—
21.86		—	—	94.45	6.76	—	—	95.66	7.09	—	—	—	—	—	—	—	—
25.20	With 33⅓ per cent dicalcium silicate	—	—	40.00	1.97	—	—	26.70	1.24	—	—	—	—	—	—	—	—
21.86		—	—	35.6	1.49	—	—	—	—	—	—	—	—	—	—	—	—
	DICALCIUM SILICATE																
18.09	No calcium sulphate added	—	—	—	—	—	—	7.7	0.24	—	—	14.0*	0.45	32.0	0.72	77.7	3.56
21.56		—	—	—	—	—	—	7.6	0.28	—	—	17.3*	0.66	20.7	0.80	73.8	3.88
18.09	1.6 per cent calcium sulphate added	—	—	—	—	—	—	8.2	0.26	—	—	21.2	0.69	29.8	1.01	—	—
21.56		—	—	—	—	—	—	9.2	0.34	—	—	17.7	0.68	21.5	0.79	71.6†	3.19
	Mean	—	—	—	—	—	—	—	0.28	—	—	—	0.62	—	0.83	—	3.54
	Mixtures:																
21.56	10 per cent tricalcium aluminate	—	—	7.0	0.26	—	—	66.9	3.33	—	—	60.6*	2.88*	—	—	—	—
21.56	10 per cent calcium ferro-aluminate	—	—	—	—	—	—	—	—	—	—	44.3*	1.91*	—	—	—	—
	SYNTHETIC PORTLAND CEMENT																
	Tricalcium silicate 65 per cent Dicalcium silicate 27 per cent Tricalcium aluminate 6 per cent Calcium ferro-aluminate 2 per cent (SiO_2 27.1 per cent, Al_2O_3 2.7 per cent, Fe_2O_3 0.7 per cent, CaO 69.5 per cent.)	—	—	27.4	1.19	—	—	90.05	6.98	—	—	—	—	—	—	—	—

*8 days. †5 months. ‡5¾ months.

The mixture made up to approximate roughly commercial portland cement, and having an analysis as calculated of 27.1 per cent SiO_2, 2.7 per cent Al_2O_3, 0.9 per cent Fe_2O_3 and 69.3 per cent CaO, was nearly completely hydrated in 24 hours. Commercial portland cement clinker grains of similar size required several months to reach a similar degree of hydration.

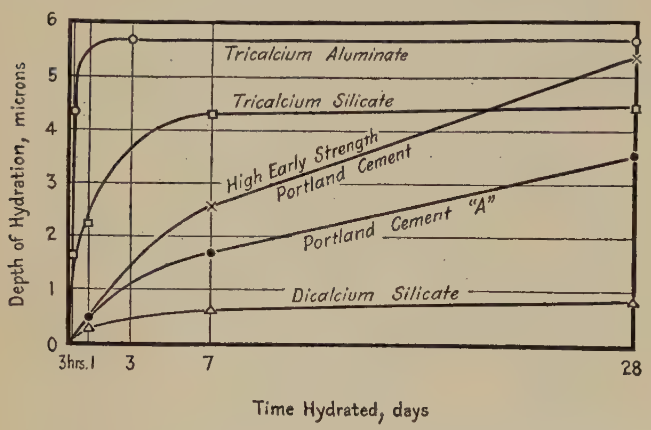


Fig. 2. Depth of hydration, at given time intervals, of several minerals found in portland cement

Acknowledgment

Grateful thanks are due R. H. Bogue of the Portland Cement Association Fellowship at the U. S. Bureau of Standards for supplying the minerals and to Mildred Staples for the painstaking and skillful counting of so many small particles.

The "Health Man" Looks at Cement Plant Dust Collection

Up to date cement works are fairly free from dust. The air in such an institution should not predispose to either consumption or pneumonia, states Dr. W. A. Evans, in the Chicago Tribune. Recently Dr. Hall, state health director of Illinois, and his board were invited to inspect the Buffington cement works and the Gary steel mills. In the Buffington plant they found that the various machines which were great dust producers were operating under suction pipes with draft sufficiently strong to pull the dusty air out of the room. The dust was conducted to high stacks equipped with Cottrell dust removers. The Cottrell method consists in sending a sheet of electricity across the stack and, therefore, through the dust laden, ascending current of smoke and air. When this apparatus was in use the air and smoke pouring from the stack was almost dust free. When the current was turned off and the Cottrell installation was not working, a black mixture rolled from the stack, polluting the air for a long distance roundabout.

Over in one corner was an old plant built and operating under the old system. It was enveloped by a cloud of dust. Dust issued from all the openings and belched from the stacks. The visitors were told that the new method not only secured clean air and all that that implied for the health and welfare of the workmen, but that in saving 95 per cent of the cement which formerly went out the stacks it was earning its way as a financial proposition.

Also, continues Dr. Evans, in the Gary plant there is an enormous bank of producer engines. These engines are run by gases which, under the old system, escaped from the stacks of old style steam making apparatus. These gases are now saved and used as fuel with enormous saving in cost of operation. To a health man the chief point of interest was that these gases contain harmful compounds, some violently poisonous. Under the old order they caused cases of gas poisoning and, in some measure, they poisoned the general atmosphere.

American Cement Plants Victorious in Highway Cement Bidding

The South Carolina state highway department contracts for more than a million barrels of cement, which, it appeared in June might go to foreign mills, have been awarded to American manufacturers. First shipments were made July 1st.

The following plants are included: Carolina Portland Cement Company, Charleston, S. C.; National Cement Company, Birmingham; Lehigh Portland Cement Company, Birmingham; Lone Star Cement Company, Birmingham; Pennsylvania-Dixie Cement Corporation, New York, and Signal Mountain Portland Cement Company, Chattanooga.

New activity and optimism are already in force as a result of this turn of events and its effect on southern plants is evident.

Its share of the required amount will warrant the operation of the Penn-Dixie plant at Kingsport, Tenn., through the fall, where last year it was closed during that period. The Pennsylvania-Dixie Cement Corporation has been awarded a contract for 600,000 barrels, to be shipped from the company's Kingsport, Richard City, Tenn., and Clinchfield, Ga., plants.

Universal Puts 8-Hour Day Into Effect in Former Atlas Plants

Substitution of three instead of two shifts per day was completed in the plants of the Universal Atlas Cement Company on July 15th. This change places all of the company's mill on the same working hour basis of 8 hours.

Mills which were owned by the former Atlas company came under United States Steel corporation rules through the purchase of the Atlas company's properties and business in January and their consolidation with the Universal Portland Cement Company, a steel corporation susidiary. One of the rules of the latter is that no man may work more than 10 hours per day or more than six consecutive days.

Formerly some of the men employed in the Waco, Tex., and Leeds, Ala., mills worked more than 10 hours, many of them 12 hours per day.

New Classifiers and Thickener for Pittsburgh Plate Glass Plant

The Columbia division of the Pittsburgh Plate Glass Co., is planning the installation of Dorr classifiers and thickener for closed circuit grinding of raw material at the Zanesville, Ohio, cement plant.

Ideal Dividend

The Ideal Cement Company, Denver, Colorado, on July 1st paid its usual quarterly dividend of 75 cents a share, totaling $343,703. Its common stock late in June was quoted on the Denver markets at $50 bid, $52 asked.

An increase of 295,000 barrels over shipments last year was shown at the end of June.

How Mechanical Classifiers Reduce Grinding Costs

Experience of Copper Mining Industry Applicable to Grinding Problems of Cement Industry—Unit Power Consumption and Screen Analyses—Actual and Recommended Flow Sheets

By J. V. N. DORR[*] and A. D. MARRIOTT[†]

In the following paper, abstracted from the 1930 Transactions of the American Institute of Mining and Metallurgical Engineers, Milling Methods (1930), the authors describe the principles of fine grinding in connection with mechanical classifiers, as developed in the copper mining industry. Similar methods have in fact been introduced in the cement industry. In consequence, this paper has direct application to cement manufacture.—The Editors.

THIS paper reviews recent developments in the application of classification practice to the origination of fine-grinding flow sheets, and traces the history of the mechanical classifier from its initial application for separating cyanide process sands and slimes down to its present six or more distinctly different applications at copper concentrators; it undertakes to show also the advantages gained from improved classification flow sheets at these properties in terms of reduced grinding costs.

The adoption of the flotation process in recent years, and especially the development of selective flotation, has brought a demand for much finer grinding than formerly. This has caused much thought to be given to grinding efficiency, and today there is hardly a mill where the grinding flow sheet is not under close study and subject to frequent changes.

The discussion has been confined to wet fine grinding with mechanical classifiers, particularly as carried on in the copper plants of the western part of North America, and has necessarily been limited to the information obtained from contact with the machines with which the authors are familiar; i. e., the Dorr Classifier and Dorr Bowl Classifier.

Definitions

At the risk of seeming elementary, it has been thought best, for the sake of clarity, to define some of the terms used in the paper.

Classification is a mechanical operation which separates the solid constituents of a flowing pulp into two portions according to their respective settling rates. Usually it implies the removal of a finished product, called the "overflow" from a product requiring further grinding, called the "sand."

Overflow is the comparatively finer, more slowly settling portion of the original pulp, which is carried over the tail board or lip of the classifier by the flow of water.

Sand is the comparatively coarser, more rapidly settling portion of the original pulp which is discharged from the classifier by the mechanical action of the rakes.

Mill is the generic term used to describe grinding mills, whether ball, pebble, or rod mills.

Fine grinding is the reduction of crusher or roll products accomplished by mill-classifier units usually to pass a 14-mesh screen or finer.

Open-circuit grinding is a method of comminution which aims to secure the desired reduction in particle size by a single passage of the material through the mill.

Closed-circuit grinding is a method of comminution in which a partially finished mill discharge is separated by a classifier into a finished overflow product and an unfinished sand product which is returned to the mill for further grinding.

Classification

The uses of classification may be grouped under three broad headings:

1. To make a size separation; for example, a sand-lime separation so that each product may be given a different treatment.
2. For closed-circuit grinding, so that the maximum size of particle escaping from the circuit may be limited, and so that the useful work done by the mill may be increased by enabling the mill to operate largely in reducing oversize rather than in overgrinding material already fine enough. [Especially applicable to cement mills.—Ed.].
3. For different grinding of the heavy mineral constituent and the gangue, by selective classification which concentrates the mineral in the sand product and causes it to be ground finer than the gangue before it can escape in the overflow product.

The desired function, together with the mesh of separation, determines the selection of the proper size and type of classifier. The Dorr classifier and bowl classifier are in use for making separations from as coarse as 10-mesh to as fine as 350-mesh.

Evolution of Present Fine-Grinding Flow Sheets

Open-Circuit Grinding.—The first application of the mechanical classifier was to open-circuit work with grinding mills in the cyanidation of gold and silver ores, for the purpose of producing two products—a slime-free sand for treatment by percolation and a sand-free slime for treatment of agitation and filtration or decantation.

Closed-Circuit Secondary Mills.—Advances in the art of treating cyanide slimes and the reduced cost of fine grinding made possible by the early tube mills led to the use of the mechanical classifier as a means of controlling the fineness of the pulp, leaving the grinding plant as feed to the all-slime cyanide treatment. Operating in closed-circuit with the tube mills, the classifier not only controlled fineness more accurately but greatly reduced grinding costs.

---

[*] President, The Dorr Company, Inc.

[†] Metallurgical Engineer, The Dorr Company, Inc.

Closed-Circuit Primary Mills.—The adoption of two-stage fine grinding, due to a recognition that too great a size reduction in one mill with one ball charge was uneconomical, led to the use of the primary mill and subsequently a mechanical classifier in closed circuit with it. Reductions in grinding costs were again obtained, and in addition a convenient means was provided for apportion-

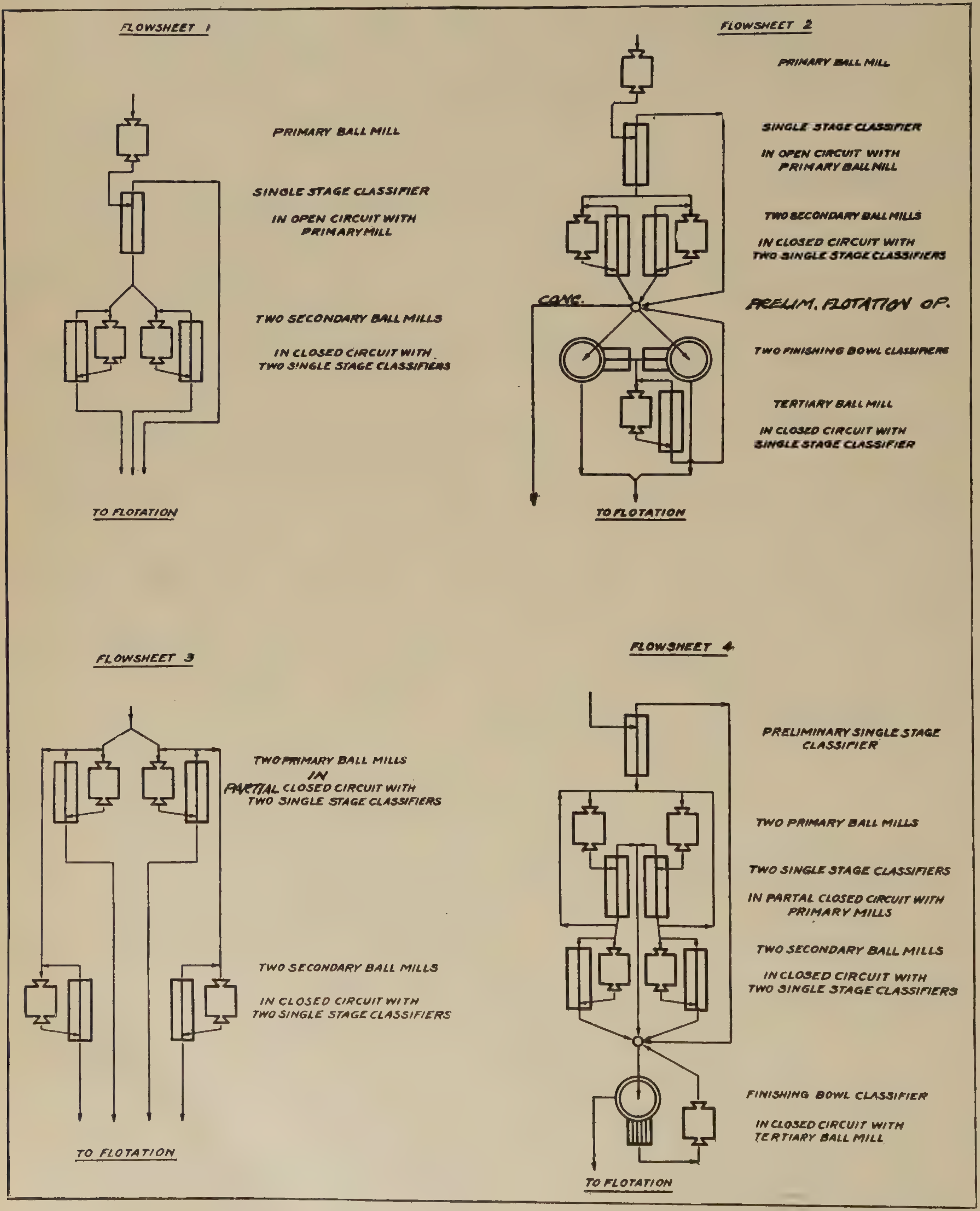

FLOWSHEET 1
PRIMARY BALL MILL
SINGLE STAGE CLASSIFIER
IN OPEN CIRCUIT WITH PRIMARY MILL
TWO SECONDARY BALL MILLS
IN CLOSED CIRCUIT WITH TWO SINGLE STAGE CLASSIFIERS
TO FLOTATION
FLOWSHEET 2
PRIMARY BALL MILL
SINGLE STAGE CLASSIFIER
IN OPEN CIRCUIT WITH PRIMARY BALL MILL
TWO SECONDARY BALL MILLS
IN CLOSED CIRCUIT WITH TWO SINGLE STAGE CLASSIFIERS
CONC.
PRELIM. FLOTATION OF.
TWO FINISHING BOWL CLASSIFIERS
TERTIARY BALL MILL
IN CLOSED CIRCUIT WITH SINGLE STAGE CLASSIFIER
TO FLOTATION
FLOWSHEET 3
TWO PRIMARY BALL MILLS
IN
PARTIAL CLOSED CIRCUIT WITH
TWO SINGLE STAGE CLASSIFIERS
TWO SECONDARY BALL MILLS
IN CLOSED CIRCUIT WITH TWO SINGLE STAGE CLASSIFIERS
TO FLOTATION
FLOWSHEET 4
PRELIMINARY SINGLE STAGE CLASSIFIER
TWO PRIMARY BALL MILLS
TWO SINGLE STAGE CLASSIFIERS
IN PARTAL CLOSED CIRCUIT WITH PRIMARY MILLS
TWO SECONDARY BALL MILLS
IN CLOSED CIRCUIT WITH TWO SINGLE STAGE CLASSIFIERS
FINISHING BOWL CLASSIFIER
IN CLOSED CIRCUIT WITH TERTIARY BALL MILL
TO FLOTATION

Fig. 1. Grinding flow sheets, Miami Copper Co.

ing the work between the two stages.

Intermediate Classification Between Stages of Fine Grinding.—The next step was the interposition of a bowl classifier between the primary and secondary grinding circuits. This classifier operated in open circuit, receiving as its feed the overflow from the primary circuit, overflowing material of finished size and discharging a clean sand product direct to the closed-circuit secondary mill. This materially improved operating conditions in varying degree at different plants in accordance with the arrangement of the preceding flow sheet.

Finishing Bowl Classifiers.—Finishing the entire flotation feed in a bowl classifier, with provision for regrinding the sands in a separate or tertiary circuit, first proved attractive in the cyanidation of gold ores in which the values were chiefly associated with the heavy pyrite constituent.

Preliminary De-sliming Classifier.—The product from the last stage of crushing generally contains some material of finished size and always a certain amount that is finer than the overflow of the primary classifiers. Accordingly, preliminary classifiers have recently been installed at several plants between the last stage of crushing and the first stage of fine grinding. Operating in this manner, primary slime is removed at the outset and sent direct to flotation (or to subsequent steps in the process) and the effective working capacity of the primary mills is increased.

Varied Illustrations of Improved Methods of Fine Grinding

Considerable initiative has been displayed by plant operators in applying the fundamental principles involved to a continually closer solution of their respective fine-grinding problems. To give details of the progress at all of the copper sulfide properties is beyond the scope of this paper. Therefore, the discussion is limited to one large concentrator selected as representative of the improved methods of fine grinding in vogue.[‡]

No attempt is made to compare practice at different plants, since the character of the ores and other conditions differ greatly. A comparison of different grinding flow sheets at a given concentrator is justified as long as preliminary crushing and succeeding extraction methods remain fairly constant, and this is the only comparison made in this paper.

Indices of Comparison

The basic figures upon which comparisons are made have been chosen as the best available for definitely indicating present trends. They have been secured or derived in the following manner:

Rated section tonnage is either the average tonnage handled during a test or the average over an extended normal operating period on which reliable data were available.

Unit power consumption (kilowatt-hours per ton ground), unless otherwise noted, is the daily section tonnage divided into the daily kilowatt-hour consumption of the fine-grinding section. It usually includes the power consumed not only by the cylindrical mills but also by the classifiers, pumps, conveyors, elevators and other accessories.

Comparative screen analyses were taken from actual operating records or from reports of tests, and represent conditions prevailing when the section was handling its rated section tonnage.

Tons ground per day through 100-mesh was derived by multiplying the rated section tonnage by the difference between the percentage of +100-mesh in feed and the percentage of +100-mesh in the flotation heading, both percentages being expressed as decimal fractions.

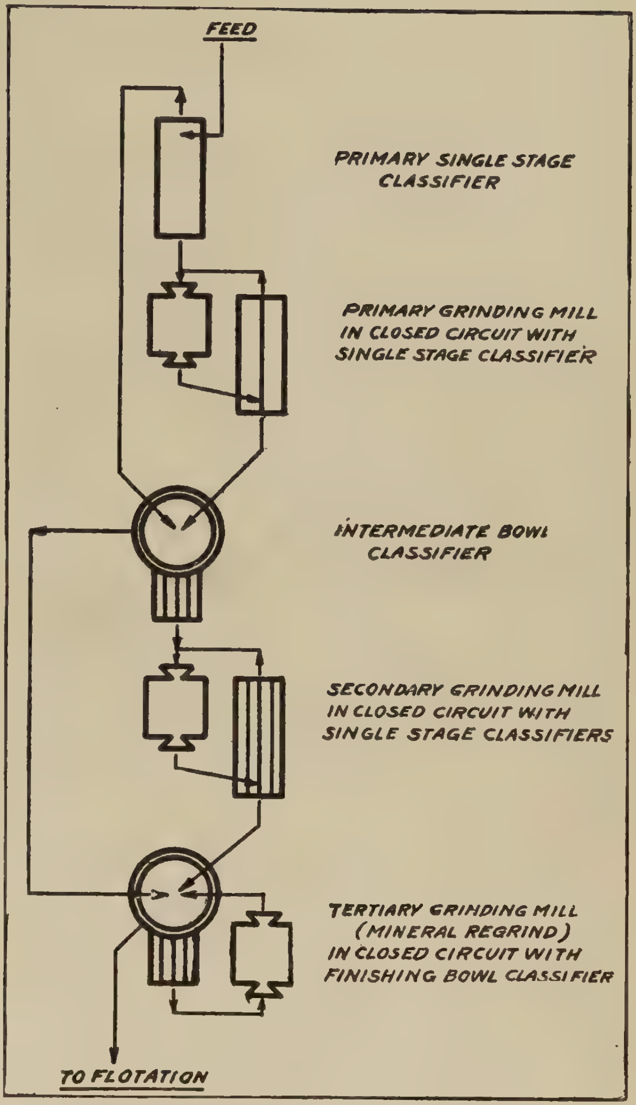

FEED
PRIMARY SINGLE STAGE CLASSIFIER
PRIMARY GRINDING MILL IN CLOSED CIRCUIT WITH SINGLE STAGE CLASSIFIER
INTERMEDIATE BOWL CLASSIFIER
SECONDARY GRINDING MILL IN CLOSED CIRCUIT WITH SINGLE STAGE CLASSIFIERS
TERTIARY GRINDING MILL (MINERAL REGRIND) IN CLOSED CIRCUIT WITH FINISHING BOWL CLASSIFIER
TO FLOTATION

Fig. 2. Suggested grinding flow sheet

Miami Copper Co., Miami, Arizona

The Miami Copper Co., as shown by the flow sheets in Fig. 1, and comparative operating data furnished by H. D. Hunt, mill superintendent, and R. L. Montjoy, metallurgist, has gone through four stages of experimentation in the development of fine-grinding flow sheets. Flow Sheets 1, 2 and 3 were used at various times from 1923 to 1929, while Flow Sheet 4 represents the final development as of August, 1929, which, excepting the preliminary classifiers used only in two sections, is now in use in all of the six sections. (Tables 1 and 2.)

Whereas the first flow sheet provided only for closed-circuited secondary mills, the succeeding flow sheets demonstrated the desirability of partly closing the primary circuit, finishing all flotation heading in bowl classifiers, in closed circuit with tertiary regrind mills, and de-sliming the roll product before introduction into the primaries. All of these features have been incorporated in the final Flow Sheet 4.

There has been a progressive stepping up of the tonnage handled per section from 1278 tons per day to 2821 tons per day, and this has been accomplished without a corresponding increase in grinding cost, as evidenced by the unit power consumption of 5.84 kilowatt-hour per ton in Flow Sheet 4 as against 6.23, 7.24 and 7.16 in Flow Sheets 1, 2 and 3 respectively.

[‡] In the original paper the authors discuss the results of installations at nine copper concentrators in western North America.

A study of the table of comparative screen analyses (Table 2) shows that the tendency recently has been to grind coarser prior to the first step in flotation, and for this reason the unit power consumption per ton of —100-mesh and —200-mesh does not show the decreases that might be expected.

TABLE 1

Comparative Capacities and Unit Power Consumptions, Miami

	Flow Sheet 1	Flow Sheet 2	Flow Sheet 3	Flow Sheet 4
Rated section tonnage per day	1278	1483	1480	2821
Unit power consumption, kilowatt hours per ton milled	6.23	7.24	7.16	5.84
Tons ground per day through 100-mesh	804	1043	969	1552
Power consumption, kilowatt-hours per ton—100 mesh	9.90	10.29	10.94	10.61
Tons ground per day through 200-mesh	616	762	721	1131
Power consumption, kilowatt-hours per ton—200-mesh	12.92	14.09	14.69	14.56

The density of flotation heading has increased, especially after the introduction of the large finishing bowl classifier in Flow Sheet 4, overflowing to flotation at 38 per cent solids.

Miami practice today is an example of three-stage fine grinding with all flotation heading originating at a single point, convenient for adjustment of density and fineness. Ample classifier capacity ahead of and between the various stages, with the exception of the under-capacity secondary classifiers, permits finished material to escape quickly as soon as it has received the treatment intended by that particular stage.

Summary

As a means of summarizing the conclusions, a generalized flow sheet is shown (Fig. 2) which may be regarded as a composite picture of developments to date. Much thought has been devoted to this flow sheet. It visualizes an arrangement which might have been adopted in many of these concentrators had local conditions permitted. Data exist to prove the value of each of the steps of this flow sheet at one or more concentrators. There is a probability, of course, that this arrangement will soon be antiquated. It would seem, however, that the composite picture may serve as a stepping stone for further improvements in fine-grinding practice.

Portland-Three Forks Plant Resumes Capacity Operation

The Portland Three-Forks Cement Company plant at Hanover, Montana, opened at full capacity on June 21st for the first time since late in 1929. There are now 175 men on the payroll and this number will be retained until winter, according to J. C. Capper, superintendent.

Operation was begun early in the year on a small scale. Full capacity operation has not been possible before because of the lack of an adequate coal supply.

Alpha Dividend Drops 50 Per Cent

The Alpha Portland Cement Co., Easton, Pa., declared a quarterly dividend of 50 cents on its common stock payable July 25th to stock of record July 1st, placing the stock on a $2 annual basis.

Heretofore the company has been paying quarterly dividends of 75 cents.

Pacific Dividend

Directors of the Pacific Portland Cement Company in June declared the regular quarterly dividend of $1.62½ on the preferred stock, payable July 5th to stockholders of record June 20th.

Bauxite in India

Large deposits of bauxite of an excellent quality have been discovered in India and British cement and aluminum interests are preparing to exploit them on an important scale.

TABLE 2

Comparative Screen Analyses, Miami

	Flow Sheet 1							Flow Sheet 2						
	Tons	Per Cent Cu.	Per Cent Solids	+48	+65	+100	—200	Tons	Per Cent Cu.	Per Cent Solids	+48	+65	+100	—200
Section feed	1278	1.81	100	76.4	78.7	81.5	14.6	1483	1.64	100	77.9	79.8	82.4	13.8
Preliminary classifier overflow	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Primary mill discharge	1278	1.81	65.0	49.6	55.3	61.3	29.0	1483	1.64	74.7	58.3	62.7	67.7	25.4
Primary classifier overflow	472	1.60	28.1	0.8	5.0	13.6	69.3	494	1.60	39.0	8.5	15.5	25.8	59.0
Secondary mill discharge	2414	2.99	70.0	33.8	49.3	62.0	24.0	3169	—	73.5	48.2	59.4	68.6	21.2
Secondary classifier overflow	806	1.85	35.1	1.8	8.8	22.2	55.2	989	1.73	36.0	5.8	14.6	28.6	51.8
Finishing bowl classifier feed	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Finishing bowl classifier overflow	—	—	—	—	—	—	—	1483	—	22.8	0	2.2	12.1	65.2
Regrind mill discharge	—	—	—	—	—	—	—	2022	0.77	63.4	14.0	40.8	66.5	83.2
Regrind classifier overflow	—	—	—	—	—	—	—	1142	0.56	47.3	8.8	30.1	58.8	77.4
Flotation heading	1278	1.81	33.6	1.6	7.3	18.6	62.8	1483	—	22.8	0	2.2	12.1	65.2

	Flow Sheet 3							Flow Sheet 4						
	Tons	Per Cent Cu.	Per Cent Solids	+48	+65	+100	—200	Tons	Per Cent Cu.	Per Cent Solids	+48	+65	+100	—200
Section feed	1480	1.69	100	80.9	82.9	85.2	11.6	2821	—	97.0	75.6	78.4	81.8	13.7
Preliminary classifier overflow	—	—	—	—	—	—	—	471.1	—	39.7	17.5	23.8	33.1	52.6
Primary mill discharge	2335	1.75	71.2	52.3	60.2	67.3	23.5	3171	—	65.6	62.2	67.1	73.3	19.9
Primary classifier overflow	623	1.55	26.7	0.3	1.8	9.0	72.0	1529	—	53.9	40.5	48.5	57.2	31.7
Secondary mill discharge	2150	2.63	69.0	32.1	48.9	62.2	24.8	1693	—	63.7	39.9	50.1	60.2	27.9
Secondary classifier overflow	856	2.04	31.8	5.6	16.7	34.3	43.8	821	—	38.8	14.1	26.0	39.2	43.2
Finishing bowl classifier feed	—	—	—	—	—	—	—	7404	—	57.1	35.1	48.7	60.2	27.5
Finishing bowl classifier overflow	—	—	—	—	—	—	—	2821	—	38.0	3.9	13.2	26.8	53.8
Regrind mill discharge	—	—	—	—	—	—	—	—	—	68.9	40.5	55.3	69.9	18.6
Regrind classifier overflow	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Flotation heading	1480	1.69	29.6	2.3	7.5	19.7	60.3	2821	—	38.0	3.9	13.2	26.8	53.8

Cement Statistics for June

Country's Plants Show Decreases in Shipments for the Month and for the Year to Date—Stocks 6 Per Cent Higher

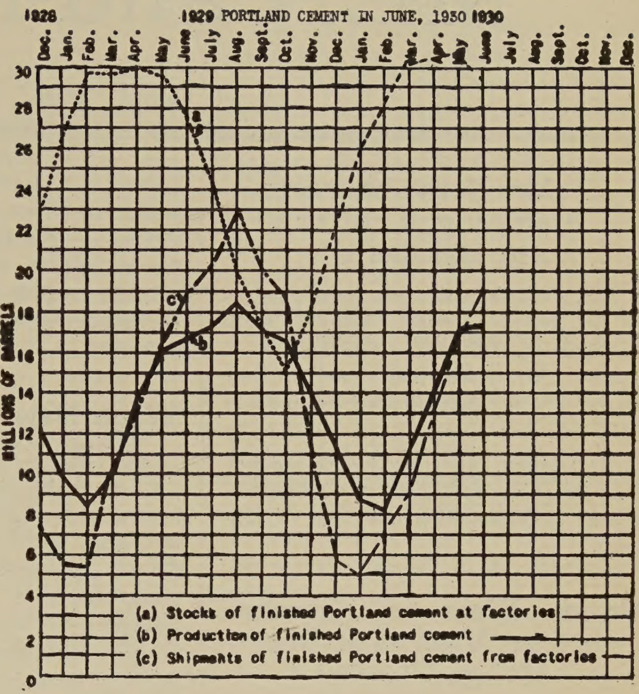
Relation of Production to Capacity

(Figures represent per cent)

	June 1929	June 1930	May 1930	April 1930	March 1930
The month	80.9	**81.4**	78.9	64.0	51.5
The 12 months ended	**69.0**	66.4	66.2	66.0	66.1

	1929	1930	Increase or Decrease (—) Per Cent
Production, June	16,803,000	**17,237,000**	2.6
Shipments, June	**18,949,000**	18,780,000	—0.9
Stocks at end of June	27,505,000	**29,348,000**	6.7
Total production for year to date	75,040,000	**75,892.000**	1.1
Total shipments for year to date	**70,248,000**	70,137,000	—0.2
No. of plants reporting	163	**166**	3.0

NOTE: IN ORDER THAT THE READER MAY KNOW THE TREND AT A GLANCE, THE HIGHER FIGURE, WHETHER FOR EITHER YEAR, UNDER ANY CLASSIFICATION, APPEARS IN SLIGHTLY HEAVIER TYPE.



Production, Shipments, and Stocks of Finished Portland Cement, by Months, in 1929 and 1930

Month	1929—Production	1930	1929—Shipments	1930	Stocks at end of month 1929	1930
January	**9,881,000**	8,498,000	**5,707,000**	4,955,000	26,797,000	**27,081,000**
February	**8,522,000**	8,162,000	5,448,000	**7,012,000**	**29,870,000**	28,249,000
March	9,969,000	**11,225,000**	**10,113,000**	8,826,000	29,724,000	**30,648,000**
April	**13,750,000**	13,521,000	13,325,000	**13,340,000**	30,151,000	**30,867,000**
May	16,151,000	***17,249,000**	16,706,000	***17,224,000**	29,624,000	***30,891,000**
June	16,803,000	**17,237,000**	**18,949,000**	18,780,000	27,505,000	**29,348,000**
July	17,315,000	....	20,319,000	....	24,525,000	....
August	18,585,000	....	23,052,000	....	20,056,000	....
September	17,223,000	....	19,950,000	....	17,325,000	....
October	16,731,000	....	18,695,000	....	15,381,000	....
November	14,053,000	....	11,222,000	....	18,213,000	....
December	11,215,000	....	5,951,000	....	23,550,000	....
	170,198,000	....	169,437,000	....	....	....

Production, Shipments, and Stocks of Finished Portland Cement, by Districts, in June, 1929 and 1930, and Stocks in May, 1930

District	Production—June 1929	1930	Shipments—June 1929	1930	Stocks at end of month 1929	1930	Stocks at end of May, 1930
Eastern Pa., N. J. and Md.	**3,697,000**	3,397,000	**4,201,000**	3,903,000	5,852,000	**6,493,000**	6,998,000
New York and Maine	1,197,000	**1,271,000**	**1,383,000**	1,381,000	**2,009,000**	1,737,000	1,847,000
Ohio, Western Pa., and W. Va.	1,885,000	**1,924,000**	2,046,000	**2,119,000**	3,578,000	**3,908,000**	4,102,000
Michigan	1,466,000	**1,487,000**	**1,720,000**	1,459,000	2,469,000	**2,813,000**	2,785,000
Wis., Ill., Ind., and Ky.	2,305,000	**2,336,000**	**2,706,000**	2,552,000	3,650,000	**4,591,000**	4,808,000
Va., Tenn., Ala., Ga., Fla., and La.	1,279,000	**1,316,000**	**1,285,000**	1,180,000	**2,111,000**	2,001,000	1,865,000
Eastern Mo., Ia., Minn., and S. Dak.	1,607,000	**1,987,000**	2,123,000	**2,412,000**	**3,745,000**	3,203,000	3,628,000
W. Mo., Nebr., Kans., Okla., and Ark.	1,089,000	**1,322,000**	1,126,000	**1,404,000**	1,492,000	**1,725,000**	1,807,000
Texas	554,000	**558,000**	579,000	**706,000**	510,000	**688,000**	836,000
Colo., Mont., Utah, Wyo., and Idaho	**325,000**	300,000	**336,000**	296,000	506,000	**566,000**	563,000
California	**1,110,000**	953,000	**1,113,000**	950,000	995,000	**1,079,000**	1,077,000
Oregon and Washington	289,000	**386,000**	331,000	**418,000**	**588,000**	544,000	575,000
	16,803,000	**17,237,000**	**18,949,000**	18,780,000	27,505,000	**29,348,000**	30,891,000

MEN and MILLS

Notes from the Field

Coulson Joins Nebraska Company; Latimer to Marquette

J. E. Coulson is the new superintendent of the Nebraska Cement Company's plant at Superior, Nebraska, succeeding B. J. Latimer. Mr. Latimer has joined the Marquette Cement Manufacturing Company as chief engineer.

Mr. Coulson was formerly sales engineer with the Oliver United Filters Company in charge of cement filter sales east of Chicago.

Smith, Klein and Overton Recent Visitors at Des Moines Plant of Penn-Dixie

Recent visitors at the Des Moines, Iowa, plant of the Pennsylvania-Dixie Cement Corporation were Blaine Smith, president; W. Klein, general manager, southern division of Penn-Dixie, and Lewis Overton, International Cement Corporation yard man at Bonner Springs, Kansas.

Wabash Entertains Dealers in Annual Gathering

The annual all-day gathering of dealers and friends of the Wabash Portland Cement Company was held at the Stroh, Indiana, plant on June 17th. Guests inspected the plant and fished on the banks of the nearby Turkey lake.

E. H. Moeller, district sales representative at Fort Wayne, was in charge of arrangements. R. M. Waddell acted as toastmaster.

Horvoath Rejoins Alpha at Manheim

Stephen Horvoath, who had been employed by the Alpha Portland Cement Co. at Manheim, W. Va., for a period of 15 years prior to 1929, and who has resided at Hagerstown, Md., for the past year, has returned to the Manheim plant as repairman.

Safety Council Playlet Offered to Members

Members of the National Safety Council, Cement Section, Chicago, have been advised that they may secure from the council copies of a safety playlet, for presentation at accident prevention meetings. It concerns a bluffing executive, head of a non-co-operative organization, who publicly expounds on safety until he is forced to realize the state of conditions in his own plant.

Webb New Universal Atlas District Sales Manager

C. A. Webb has been appointed district sales manager in charge of the city of Chicago district for the Universal Atlas Cement Company, according to an announcement by F. L. Stone, general sales manager. He succeeds W. L. Greenly, district sales manager, who has been transferred to the general sales office.

Mr. Webb has been with the Universal Atlas company 13 years, including a leave of absence at the time of the World War when he served in France as an officer in the American army. For more than two years he was technical service engineer for the company and for about eight years has been in its sales department.

Mr. Webb is a graduate civil engineer from the University of Arkansas and also has a master's degree in engineering from Columbia university. Prior to his connection with the Universal Atlas company he was with the Chicago, Milwaukee & St. Paul railroad engaged in valuation work. He later was in the employ of the American Tar Company, Boston, in charge of highway construction and maintenance. He also was connected with the Kansas City Terminal Railway Company and helped to design the double-tracked railroad structure in the Union station of that city.

He is a member of the Western Society of Engineers and of the Builders' club and an associate member of the American Society of Civil Engineers.

Knott's Health Improved; Returns to Work

Everett Knotts, World War veteran and repairman in the kiln department of Manheim, W. Va., plant of the Alpha Portland Cement Company, has returned from the Walter Reid hospital at Washington, D. C., where he had been taking treatment for injuries received while in France. He is much improved and expected to return to work by the first of August.

Manheim Turns Out for Tennis Tournament; Gibson and Felty Lead

A one-day tennis tournament attended by a greater part of the community was held on Sunday, July 13th, at Manheim, W. Va. Twenty employes of the Alpha Portland Cement Company plant there were entered.

F. W. Gibson, timekeeper, won in the singles and he and Lucian Felty won the tournament in the doubles.

Refreshments were served at noon.

Sutherland Addresses Houston Industrial Safety Group

R. G. Sutherland, manager of the Trinity Portland Cement Company, was the principal speaker during the regular meeting of the Houston Industrial Safety association on June 18th.

The meeting was the fourth of a series sponsored by the safety association as a part of an accident reporting contest it is sponsoring among 50 industrial plants of the city.

Universal Atlas Opens New Jersey Offices

Newark, New Jersey, offices have been opened by the Universal Atlas Cement Company, in the Lefcourt-Newark building.

H. F. Van Wagner, district sales manager for the New Jersey division, will continue in charge.

Northwestern Portland Offices Moved

The executive offices of the Northwestern Portland Cement Company, located at 1104 Wilcox Building, Portland, Oregon, have been transferred to the general office at 1390 Horton Building, Seattle, Washington.

Hermitage Portland Moves Offices

The offices of the Hermitage Portland Cement Co. have been removed from 174 Third Avenue, North, to 902 American Trust Building, Nashville, Tenn.

W. W. Binford Leaves West Penn to Join Allis-Chalmers

W. W. Binford, until recently chief engineer of the West Penn Portland Cement Company at Winfield, Pa., has left that firm to join the sales force of the Allis-Chalmers Manufacturing Company in the Crushing, Mining and Cement Mill Machinery division.

Superior Portland Picnic Is Big Event

The fourth annual employes' picnic sponsored by Superior Portland Cement, Incorporated, was to be held at a local picnic ground on Saturday, July 26th.

The program was to begin at 10 o'clock with a baseball game between the Bellingham Coal Miners and the All-Star Superior team. Immediately following the baseball game, contests were to be held and a barbecued salmon dinner served. Dancing was to take place at a nearby hall.

The committee in charge includes Vice-President C. L. Wagner, Superintendent H. A. Ambler, Assistant Superintendent J. P. Brooks, and Foremen C. E. Hutchinson, Ross Zongrone, Tony DeSalvo, Ole Nelson, Robert Lang, and Wm. Woodworth.

Parry, of Glens Falls, Dies at Summer Home

John E. Parry, 71, secretary of the Glens Falls Portland Cement Company, Glens Falls, N. Y., was found dead in bed at his summer home at Bolton, Lake George, N. Y., on July 1st.

Mr. Parry had been connected with the organization about thirty-five years. He was also vice-president of the National Bank of Glens Falls and a graduate of Union college.

Lone Star Entertains Employes on Fourth of July Eve

Employes of the Dallas plant of the Lone Star Cement Company of Texas were entertained with a barbecue on Thursday, July 3rd, on the plant grounds west of the city.

Cheat River Provides Good Fishing for Alpha Employes

With good fishing prevailing in the Cheat river, near the Alpha Portland Cement Company plant at Manheim, W. Va., rivalry as to the largest fish caught is keen among employes.

Up to July 17th, Chas. Bolyard, chief electrician and engineer, was in the lead, having caught a five pound bass on July 12th.

Meacham, Universal Atlas Service Manager, in South

J. C. Meacham has taken up his duties as technical service manager in charge of service work in the states of Southern California, Georgia, Florida, Alabama, Mississippi, Tennessee and part of Louisiana, for the Universal Atlas Cement Company. His headquarters are at the Birmingham office.

Mr. Meacham was formerly technical service engineer in the territory comprised of West Virginia, Maryland, and Virginia.

Mill Equipment

Spring-Steel Screens New Ludlow-Saylor Product

Spring-Steel woven wire screens are announced as a new development by the Ludlow-Saylor Wire Company, St. Louis.

Spring-Steel is a hard, resilient alloy for severe service on revolving-screen jackets, vibrating-screen sections, and shaking and gravity screening surfaces, it is stated.

The first installation made four years ago (in 1926) is reported to be still in service. This consists of two cylindrical outside jackets on a revolving screen handling crushed limestone road ballast. These jackets have been used continuously since their installation.

Spring-Steel has also been thoroughly tested on various types of vibrating screens and can now be furnished in all the grades required for heavy sizing duty, the manufacturer states.

Bendy Kiln Feed Control System Operation

After a two-year trial, the Bendy kiln feed control system has been placed on the market by the Manitowoc Engineering Works, Manitowoc, Wis.

The system is based on the principle of having the feeder make a determined number of revolutions and then stopping until the kiln has made a certain number of revolutions. The interval of time the feeder is stopped depends upon the speed of the kiln. Thus the feed to the kiln per revolution is maintained constant.

By using a magnetic clutch in the feeder drive this control is accomplished in a simple and accurate manner, with a constant speed motor at the feeder, it is stated. A period of about 3 minutes for a complete cycle gives a uniform load in the kiln.

Thus the burner has only the variable speed motor on the kiln to operate, and the feed is changed proportionally automatically, according to the manufacturer.

New Ford Powered Brookville Locomotives

The new Ford "AA" truck power plant is utilized for light locomotive haulage by two new series of Brookville locomotives in 2, 2½, 3, 3½ and 4 ton sizes.

Larger Brookville locomotives, ranging up to 12 tons in size, are powered with Fordson, McCormick-Deering and truck and tractor power units.

NOTES FROM THE FIELD

North American Buys Refractories

The North American Refractories Company, Cleveland, Ohio, announces the purchase of the assets, good will and business of the *United States Refractories Corporation,* of Mt. Union, Pa., and the *Savage Mountain Fire Brick Company,* of Allegeny County, Frostburg, Md.

This purchase completes the North American line by adding a fine silica brick and the Savage Mountain fire brick.

St. Regis Acquires Bates International

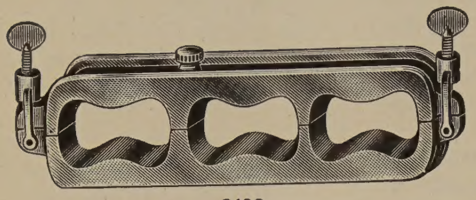
Acquisition by the *St. Regis Paper Company* of the *Bates International Bag Company,* was announced on July 15th.

The announcement states that with this new subsidiary and the Bates Valve Bag Company, purchased early this year, the St. Regis group is provided with coverage in a large part of the world for the development of Bates patents on multiwall bags, cement packers and bag manufacturing machinery.

Fuller Lehigh Company Opens Atlanta Sales Office

Announcement has been made by the *Fuller Lehigh Company,* manufacturers of pulverized-coal firing equipment and Bailey water-cooled furnace walls, of the opening of a new sales office in the Candler building at Atlanta, Georgia. *J. Mc. C. Hill* is in charge of the new office.

Laboratory Apparatus for Cement Testing



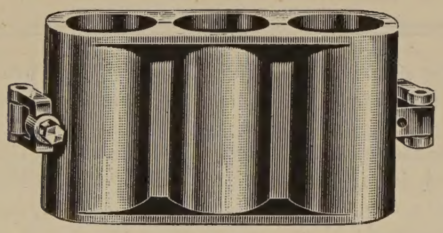
2406

Laboratory Tests for tensile strength and compressive strength of Portland Cement should be performed according to Standard A. S. T. M. Specifications. A very necessary requisite for these tests are molds according to A. S. T. M. design.

2404 BRIQUETTE MOLD—Single, of brass with end clamps for forming test pieces for tension tests. According to the dimensions specified in A. S. T. M. Test C 9-26 .... 4.20

2406 BRIQUETTE GANG MOLDS—A. S. T. M., of brass with end clamps.

No. of briquettes	2	3	4	5	6
Each	7.00	10.50	14.00	17.50	21.00



2423

2422 CYLINDRICAL MOLD—Brass, for preparing cylinders used in determining the compressive strength of Portland Cement Mortars. Diameter, 2 inches; height, 4 inches. According to the dimensions specified in A. S. T. M. Tentative Test C9-16T.......... 3.25

2423 CYLINDRICAL MOLD—Triple, for preparing three cylindrical test pieces at one time. Diameter of each cylinder, 2 inches; height 4 inches.......... 16.00

These molds are carried in stock for immediate delivery

For a complete listing of Cement Testing Apparatus and Chemical Laboratory Apparatus refer to Catalog C. Write for a copy if you do not have one.

THE CHEMICAL RUBBER CO.

Laboratory Apparatus and Chemicals

West 112th Street and Locust Avenue
Cleveland, Ohio

Canada Co. Outlook Compares Favorably with 1929

The unusually high level of earnings of the Canada Cement Company, Ltd., for the last fiscal year ending November 30, 1929, are likely to be almost equaled in 1930, although sales have been somewhat lower.

This year's continued demand for cement for the huge hydro-electric projects under construction in the Dominion is keeping up sales to a high level, in the face of falling off in some lines of building due to the general business depression.

For 12 months ended November 30th, 1929, company reported net income of $1,600,701, after depreciation, interest and reserves, equivalent after 6½ per cent preferred dividend requirements to 38 cents a share on 600,000 shares no-par common stock. This compared with net income in 1928 of $1,396,951, or 5 cents a common share.

International Earnings Lower; Directors Re-elected

The forty-second quarterly report covering the second quarter of 1930, of the International Cement Corporation, shows earnings of $1.91 per share on 631,356 shares of common stock then outstanding as compared with $1.86 per share on 619,031 shares outstanding on June 30th, 1929.

For the six months a net income is reported of $2,051,762, equal to $3.25 a share on the 631,356 shares, against $2,167,408, or $3.50 a share, on the 619,031 shares in the first six months of 1929.

Monolith Passes Usual Dividends

Directors of the Monolith Portland Cement Company on June 19th voted to omit payment of the regular semi-annual dividend of 40 cents a share on the 8 per cent cumulative preferred stock as well as a similar dividend on common stock usually payable July 2nd.

Conservation of working capital during a period of dullness in the building and other industries that consume large amounts of cement, was the underlying reason for considering omission of the dividend on the junior issue at this time, it was stated.

Czecho-Slovakian Cement Firm Distributes Big Dividend

The Czech cement firm, Fabrique de Ciment de Kraluv-Dvur, of Prague, Czecho-Slovakia, capitalized at 48,000,000 crowns, reports net profits of 28,222,000 crowns; 1,261,000 crowns have been placed in reserve and a dividend of 50 per cent distributed.

The Fabrique de Ciment de Podoli has declared a dividend of 15 per cent—30 crowns per share.

Medusa Dividend

About $278,000 was paid July 1st in dividends by the Medusa Portland Cement Co., Cleveland, Ohio. A regular quarterly dividend of $1.50 a share on 177,714 shares of no par common and $383,000 par amount of preferred to stock of record June 25th was declared.

Missouri May Change to Wet Process

Serious consideration is being given by the Missouri Portland Cement Company to the question of changing the Kansas City, Missouri, plant from the dry to the wet process.